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COVER ILLUSTRATION: *Hierbera* in Sonora Market, Mexico City (Logan et al., this issue Figure 1).

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ETHNOBIOTICA

In the past few months, there have been several changes in the editorial board of the journal. I would like to take this opportunity to thank Bill Balée, who is stepping down from the editorial board, for all his help and advice; we are fortunate that Glenn Shepard is willing to take his place. I would also like to thank Elia San Miguel for editing and translating the Spanish abstracts for the past few issues, and Annick Sullivan for providing translations in French. Beginning with this issue, Alain Cuerrier will be the consultant for French and Eraldo Medeiros Costa Neto for Portuguese. Manuel Pardo de Santayana will be the journal's Spanish consultant starting with volume 24, number 2.

It is thanks to the volunteer labor of many people—the editorial board and consultants, the many anonymous reviewers, and lest we forget, the authors—that we have been able to cover such a variety of ethnobiological topics in our journal. I hope you include the ones in this issue in your summer reading program!

Naomi

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AN EMPIRICAL ASSESSMENT OF EPAZOTE (*Chenopodium ambrosioides* L.) AS A FLAVORING AGENT IN COOKED BEANS

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ABSTRACT.—A common culinary practice in Mexico and elsewhere in Mesoamerica is the use of *Chenopodium ambrosioides* L., a small herbaceous plant known most widely as epazote, to flavor black beans and other dishes. While some people find the taste and odor of this herb to be mildly disagreeable, there are good empirical reasons for its use as a flavoring agent in cooked, unrefrigerated, foods. Through a series of experimental trials we observed that beans prepared with *C. ambrosioides* remained edible, as judged by sight and smell, long after plain beans had begun to spoil. Microbiological tests revealed significant bacteriocidal activity in this species. Epazote has a large and diverse range of potential scientific and commercial applications.

Key words: epazote, *Chenopodium ambrosioides*, Mesoamerica, culinary practices, food preservative.

RESUMEN.—Una práctica culinaria frecuentemente utilizada en México y en otras partes de Mesoamérica para darles sabor a los frijoles negros y a otras comidas es el uso de *Chenopodium ambrosioides* L., una pequeña planta herbácea comúnmente llamada epazote. Aunque algunas personas encuentran el sabor y el olor de este condimento algo desagradable, existen razones empíricas para justificar el empleo de agentes para mejorar el sabor de alimentos cocinados que no son refrigerados. A través de análisis experimentales, se observó que los frijoles preparados con *C. ambrosioides* permanecían comibles, al juzgar por la apariencia y el olor de éstos, aun cuando los frijoles comunes y corrientes habían empezado a avinagrarse. Análisis microbiológicos revelaron la actividad bactericida de esta especie. El potencial de utilización con fines científicos y comerciales de esta planta es amplio y diverso.

RÉSUMÉ.—Le *Chenopodium ambrosioides* L., une petite plante herbacée plus connue sous le nom d'ambroisie, est couramment utilisé dans la cuisine du Mexique et, de façon générale, en Méso-Amérique pour aromatiser les plats de haricots noirs ainsi que d'autres plats. Quoique certaines personnes trouvent le goût et l'odeur de cette herbe légèrement désagréable, il existe d'excellentes raisons empiriques quant à l'utilisation de l'ambroisie comme aromate dans les plats cuits et non réfrigérés. À la suite d'une série d'essais expérimentaux, nous avons observé que les haricots préparés avec le *C. ambrosioides* demeuraient comestibles—

comme on peut le noter par leur aspect et leur odeur—bien après que les haricots préparés sans la plante aient commencé à se gâter. Des tests microbiologiques ont révélé une activité bactéricide significative chez cette espèce. L'ambroisie possède un grand éventail d'applications différentes ayant un potentiel à la fois scientifique et commercial.

INTRODUCTION

Many residents of Mexico and Guatemala subsist on a diet based largely on black beans and corn tortillas. These foods, of course, have served as the cornerstone in the diet of Mesoamerican cultures for thousands of years (Mangelsdorf et al. 1964). An equally ubiquitous, and possibly ancient, culinary practice is the use of epazote (*Chenopodium ambrosioides* L.) as a flavoring agent in cooked beans.[1] As one authority on Mexican cuisine remarked, "To cook black beans without it is unthinkable" (Kennedy 1978:239). Yet many individuals, especially children and adults unaccustomed to traditional Mesoamerican foods, find the taste and odor of epazote to be mildly disagreeable (Johns 1990:284). Even the plant's common name reveals much about its pungent qualities: *epazotl,* the Aztec name for this species, is based on *epatl,* their word for skunk (Coile and Artaud 1997).[2] There are, however, sound empirical reasons for cooking beans with several leaves and stems of epazote added, reasons that far overshadow any concerns one might have regarding the plant's strong taste and odor (Figure 1).

Three different experiments were conducted to better understand why this malodorous plant is so greatly valued as a flavoring agent in cooked beans. The first and second of these tests were simple in design, yet important in outcome. Moreover, each provided results that warranted a third phase of experimental investigations into the bioactivity and phytochemistry of *C. ambrosioides.* We now turn to a discussion of our methods and findings.

EXPERIMENTAL DATA: PHASE I

The idea behind the present research originally surfaced when the senior author (ML), who has considerable fieldwork experience in Guatemala and Mexico, suspected there must be some advantageous reason for using *C. ambrosioides* to flavor cooked black beans and many other traditional foods or dishes (in addition to Kennedy 1978, see Bayless and Bayless 1987; Gerlach and Gerlach 1994; Martinez 1992; Ortiz 1967; Quintana 1986). He was also aware that many other botanicals used as spices thwarted food spoilage by curbing the growth of bacteria and fungus that rapidly invade cooked, though unrefrigerated, foods (e.g., Sherman and Hash 2001).

A simple experiment was conceived that would help resolve the enigmatic question of why it would be "unthinkable," in Kennedy's assessment, to cook black beans without epazote. With the assistance of Beth Maney, the experiment was initiated. A supply of black beans was purchased at a local grocery store. Two batches of beans (approximately 226 g [½ pound] each)—one containing fresh Mexican epazote (about a dozen whole leaves and attached stems), the other without epazote—were then cooked by vigorous boiling. This was done in the

FIGURE 1.—A *hierbera* in Mexico City's Sonora Market vends numerous fresh and dried plant products used in cooking and health care, including epazote. Photograph by Michael H. Logan.

evening. When thoroughly cooked the two batches of beans were drained, then spooned into plastic containers that were clearly labeled: "epazote" and "plain." No lids were used as the beans sat overnight at room temperature. The following morning the cooked samples were transferred out-of-doors and placed in a shaded and covered area. The month was August, with daytime highs in the lower 90s (>32°C), and evening lows in the 70s (>21°C). At 6:00 p.m. (approximately 24 hours after the beans were cooked), the senior author visually inspected the beans and then sniffed each sample. Although they looked the same, the batch without epazote had a slight odor of decay. However, the beans containing epazote smelled fresh. The samples remained out-of-doors for another evening. At 10:00 a.m. the following morning the samples were again assessed. The plain sample now exhibited signs of fungal growth. It also had a strong, disagreeable odor. Interestingly, though, the beans cooked with epazote looked and smelled fresh, save for the odor of this additive. That evening at 6:00 the plain sample was reassessed. It was thoroughly rotten, and the odor of the beans was offensive. The beans containing epazote still smelled, after approximately 48 hours, as if they remained edible. They were not eaten, however. The beans in each batch were then discarded.

This simple experiment—the "sniff test"—was repeated several times. And the results were uniformly the same. Black beans cooked with epazote remained

FIGURE 2.—Dried epazote is sold by a variety of commercial outlets in Mesoamerica and the United States. Photograph by W. Miles Wright.

fresh long after plain beans began to rot. But would use of dried epazote, rather than fresh, produce different results?

Packets of dried *C. ambrosioides* were purchased from a retail and mail order firm in Florida that specializes in herbs and spices used in preparing ethnic foods (Figure 2). The amount of epazote added to the beans followed traditional Mexican recipes (one tablespoon per half cup of beans). Interestingly, the results with dried epazote paralleled what was observed in our earlier trials. Use of fresh or dried epazote when cooking beans significantly extended the length of time during which they would remain edible, as judged by sight and, more importantly, smell.

The experiment faithfully tried to replicate the domestic environment of cooking and food storage found in the past, or among many Mesoamerican peasants today. While ceramic vessels and a wood fire were not used, the factors judged most important in these tests were to leave the cooked beans uncovered in a shaded area and at ambient daytime and evening temperatures. Reheating beans that already contained epazote would undoubtedly further extend the "shelf-life" of this staple food.

To gain better insight into the biological activity of *C. ambrosioides* as a food additive, the senior author enlisted the aid of three colleagues (the other co-authors), each having considerable laboratory experience. Additional experimentation was the logical next step.

EXPERIMENTAL DATA: PHASE II

To better control for environmental factors that could have affected the cooked samples in our earlier trials (e.g., wind-borne spores or contact by insects), we decided to place the cooked beans—those with epazote and those without—into Petri dishes, which would then be stored in an incubator at a constant temperature and light level.

The black beans were prepared in the same manner as in the previous tests. In all, three different batches of beans were cooked: two with fresh epazote (in one of these the sprigs of epazote were removed after cooking) and one without epazote. These samples were then taken to Charles Faulkner's laboratory. The beans were then placed into clearly marked, yet coded, Petri dishes. Nine dishes were used (3 with epazote left in [*ei*]; 3 with epazote removed [*er*]; and 3 plain [*p*]). Bacteria (*Micrococcus lutea*) were then added to two of the dishes in each of the three categories (*ei, er, p*), leaving one dish in each of the three groupings not spiked with bacteria. It should be noted here that only Logan knew what letters and numbers corresponded with "epazote in," "epazote removed," and "plain," as well as "bacteria yes" and "bacteria no."

All dishes were then placed inside a lighted, airtight incubator set at 26°C.[3] After 24 hours in the incubator (approximately 40 hours had elapsed since the beans had been cooked), the samples were removed and inspected (by CF) for visual signs of spoilage (e.g., any change in color or consistency). All dishes where bacteria had been added showed signs of decay, especially *p*1 and *p*2 (the plain beans with bacteria added). However, the samples prepared with epazote, but ones not containing additional bacteria (*ei*3, *er*3), showed no visible evidence of spoilage. All lids were then removed and the "sniff test" was conducted on the contents of each dish. Again, this was a blind trial. A disagreeable odor was detected (by CF) in all of the samples, save for two: the samples prepared with epazote that were not spiked with bacteria. These results warranted additional, and more rigorous, experimental trials and microbiological assessment.

EXPERIMENTAL DATA: PHASE III

Again, black beans were cooked with and without epazote in nonlaboratory conditions. El Charitto (EC) brand epazote was purchased in Mexico. One tablespoon of epazote (ca. 4 g) was added per 0.5 cup dry beans (ca. 200 g). Standard microbiological techniques were followed in order to determine bacteria counts in both samples (Harrington and McCance 1976).[4] The results were dramatic. The sample without epazote contained approximately 800 colony-forming units per ml. The sample cooked with epazote contained none. It was totally free of bacteria, yet some 42 hours had passed since the beans were cooked. After 72 hours, samples were again drawn, diluted, plated and counted. The one without epazote had more than 160 million colony-forming units per ml, while the batch with epazote had eleven thousand. These findings strongly confirmed what had been observed in our earlier trials. Epazote does extend the length of time that unrefrigerated black beans remain edible, by a magnitude of at least one full day, if not more.

Activities of EC and an epazote commercially available in the United States (Penzey's Spices [PS], Muskego, Wisconsin) were compared. The EC epazote was determined to be heavily contaminated with multiple species of bacteria that could alter bacterial counts in beans cooked with EC; therefore, for further experiments, black beans were cooked under controlled laboratory conditions using propylene oxide-sterilized epazote. Propylene oxide did not alter the chemical composition of either EC or PS epazote (data not shown). In subsequent experiments, epazote was sterilized by submersion overnight in propylene oxide that was then allowed to evaporate. To each of two sets of sterile cookware, dry black beans (200 g) and tap water (400 ml) were added. The beans were heated to boiling, then cooled to room temperature for two hours. Sterile epazote (4 g) was added to one pot and mixed well. Both batches were simmered for one hour.

The next procedure to be pursued was to assess epazote's potential, if any, to curb the growth of two common food spoilage organisms, *Escherichia coli* (O157) and *Salmonella* (8326). Again, more beans were prepared. The cooked samples were inoculated with the bacteria (10^5 per gram beans). Appropriate controls were used. Colonies were counted at 24 and 48 hours. Epazote had little or no effect on the introduced bacteria. Interestingly, the two control groups (each with epazote) had no bacteria, whereas the plain batch was laden with some type of bacteria. The naturally occurring organisms in the untreated cooked beans were classified as Gram-negative or Gram-positive by differential staining, and Gram-positive organisms were tentatively identified as a species of *Bacillus*, probably *B. cereus* (Lund et al. 2000).

In order to determine if *Bacillus* species are sensitive to epazote, both treated and untreated beans were divided into two sterile flasks to which 10^5 *Bacillus* BA101/gram beans was added to one flask of each set. The flasks were incubated at 30°C, and samples were plated at 24 and 48 hours as described above to determine bacterial counts. EC and PS were evaluated in separate experiments. Approximately ten times more bacteria were isolated from untreated beans than for beans treated with EC epazote. With the addition of *Bacillus*, there was also a tenfold reduction in the number of bacteria growing in beans cooked with epazote compared to untreated beans. There was approximately twice the number of bacteria in untreated beans compared to beans cooked with PS epazote. Apparently these brands of epazote differ in their phytochemical composition, with EC epazote exhibiting greater bacteriocidal activity than PS epazote.

Dr. Duke's Phytochemical and Ethnobotanical Database was used to identify commercially-available antibacterial compounds that had previously been isolated from *Chenopodium ambrosioides*.[5] Nine compounds were tested for activity against several types of bacteria, including Gram-positive and Gram-negative organisms isolated from beans, *Salmonella* 8326, and nine strains of *Bacillus* (Table 1).[6] Geraniol and safrole were the only compounds of the nine tested that inhibited the growth of bacteria (Bard et al. 1988).

TABLE 1.—Antibacterial properties of epazote compounds.

	G (+)[1]	G (−)[1]	Sal 8326	BA 77	BA 101	E 21	E 61	E 65	E 66	E 69	E 726	E 727
Cymene	—[2]	—	—	—	—	—	—	—	—	—	—	—
Limonene	—	—	—	—	—	—	—	—	—	—	—	—
Myrcene	—	—	—	—	—	—	—	—	—	—	—	—
Geraniol	15[3]	12	11	12	14	12	11	12	15	13	12	12
Pinene	—	—	—	—	—	—	—	—	—	—	—	—
Safrole	13	10	9	8	11	10	10	10	11	10	10	10
Ferulic acid	—	—	—	—	—	—	—	—	—	—	—	—
Vanillic acid	—	—	—	—	—	—	—	—	—	—	—	—
Ascorbic acid	—	—	—	—	—	—	—	—	—	—	—	—
Control	—	—	—	—	—	—	—	—	—	—	—	—

Ten μl of undiluted cymene, limonene, myrcene, geraniol, pinene, or safrole was added to a sterile filter paper disk. Ten μl of ferulic acid (50 mg/ml in 95% ethanol), vanillic acid (50 mg/ml in 95% ethanol), or ascorbic acid (100 mg/ml) was added to a sterile filter paper disk. The treated disk was placed on a lawn of bacteria obtained by spread plating one ml 10^5 bacteria/ml suspension on TSA plates. After 24 hours the cleared zone around the filter paper disk was measured.

[1] G(+) and G(−) organisms were naturally occurring isolates from beans; Sal 8326 = *Salmonella*; BA and E = isolates of *Bacillus*.

[2] — No effect of compound on bacterial growth.

[3] Measurements are cleared diameters in mm.

DISCUSSION

The traditional use of epazote to flavor cooked beans is an empirically sound practice. Geraniol and safrole effectively retard the growth of *Bacillus* bacteria, which is a natural component in bean spoilage. This would have been particularly important in the past, as well as in contemporary settings where a sizeable number of persons lack electricity and refrigeration (Valdes-Ramos and Solomons 2002: 149). Because this species safely extends the period of time that unrefrigerated cooked beans remain edible, its potential as a preservative in other dishes, both vegetarian and meat-based, certainly warrants additional study.

Preliminary findings on a closely related species—*Chenopodium berlandieri* Moq.—suggest that it, too, retards the rate of spoilage in cooked beans due to fungal invasion. Fresh *C. berlandieri* was acquired from a local farm in Blount County, Tennessee, and three batches of black beans were prepared following the same practices done with the epazote tests described above. Beans cooked without *C. berlandieri* exhibited significant amounts of mold after 48 hours, while the control sample with *C. berlandieri* added before cooking appeared to be suitable for consumption. The third batch, prepared with dried *C. berlandieri* achenes also looked and smelled fresh some two days after they were cooked.

These trials, though simplistic, are especially interesting because this species of *Chenopodium* held an important place in the diet of prehistoric Indians in the eastern woodlands of North America as early as three to four thousand years ago (Fritz 1999; Gremillion 1993; Smith 1984, 1985a, 1985b). Perhaps these peoples, like their counterparts in Mesoamerica, had discovered the food preservation qualities of *Chenopodium*. Our research on *C. berlandieri* continues, yet it should be noted here that both *C. berlandieri* and *C. ambrosioides* were eventually domesticated by aboriginal peoples in the past. Domestication confirms how culturally important these species once were.

In Mesoamerica, though, the cultural importance of *C. ambrosioides* has persisted to the present day (e.g., Heiser 1985:82–99). Aside from its role as a flavoring agent, and by extension a food preservative, it is eaten fresh as a potherb by Indians in northern Mexico (Bye 1981:116). Leaves and stems of this plant contain important amounts of calcium, phosphorous, and vitamin C (Ortiz de Montellano 1990:240). The fruits or achenes of epazote, which are rich in protein, also hold value as a food (Minnis 2000:223). While most residents of the United States would view chenopods to be lowly weeds, these plants have considerable worth as an alternative crop (Coile and Artaud 1997).

Epazote is also culturally valued for its medicinal properties (e.g., Moerman 1998; Morton 1981). It is widely used in the Americas and beyond to combat a large array of health-related problems. Frequently it is the remedy of choice for controlling intestinal worms (Berlin et al. 1996:413–417), yet its efficacy as a vermifuge in humans is, to some degree, uncertain (Kliks 1985; but also see Kightlinger et al. 1996).[7] While epazote's role as a curative must be of considerable antiquity, this cannot be determined archaeologically. However, it is described as a useful medicinal herb in early post-Conquest ethnohistorical sources (e.g., Orellana 1987). The volume of literature on *C. ambrosioides* as a medicinal plant far overshadows what has been published on this species as a dietary item.

In addition to its bacteriocidal properties, *C. ambrosioides* has been shown to possess other realms of biological activity. It is a strong allelopathic species, in that its leaves exude compounds that prohibit or delay seed germination of other nearby species (Jimenez-Osornio et al. 1996). Researchers have also learned that *C. ambrosioides* has insecticidal and repellent properties (Morsy et al. 1998; Su 1991; Tapondjou et al. 2001). Antiviral (Verma and Baranwal 1983), antifungal (Kishore et al. 1989; Montes-Belmont and Carvajal 1998), trypanocidal (Kiuchi et al. 2002), and molluscicidal (Hmamouchi et al. 2000) activities have also been reported for this species. Other studies have shown that *C. ambrosioides* has hypotensive (Gohar and Elmazar 1997) and antidermatophytic (Kishore et al. 1996) activities as well. It becomes obvious that this species has a vast number of potential uses, and in a variety of industries, ones ranging from agriculture and pest control to human (Lall and Meyer 1999) and veterinary medicine (Perezgrovas et al. 1994).[8]

CONCLUSIONS

Precisely when and where prehistoric peoples of Mesoamerica discovered the food-preservation qualities of epazote is not known. How this discovery was made, though, is easier to reconstruct. Olfaction was undoubtedly the critical element lying behind this acquired knowledge concerning *C. ambrosioides.*

The Archaic Period of Mesoamerican prehistory (ca. 8000 B.C. to 2000 B.C.) witnessed a huge number of cultural innovations. None was equal in importance to the domestication of plants. Dozens of different species were transformed from their wild states into useful foods (West and Augelli 1989:220). By 2000 B.C., maize and beans held an important place in the diet of these early peoples. They, and no doubt their predecessors, also consumed *C. ambrosioides* (Manglesdorf et al. 1964:434). There is clear evidence that the seeds of this plant were roasted and eaten. It is also highly probable that fresh leaves and stems were eaten as well. Placing sprigs of this edible potherb into a stone, and later ceramic, vessel that contained beans and water brought to a boil would be a logical method of adding volume, if not variety, to a meal soon to be eaten. Leftover beans would remain in the vessel or a gourd bowl until reheated for the next meal. And humans invariably employ smell, coupled with sight, as a proximate gauge of a food's edibility.

The results of our original experimental trials—the "sniff" test—revealed, in no uncertain terms, that beans prepared with epazote seemed safe to eat long after the beans lacking epazote smelled foul. The same observation undoubtedly occurred, and repeatedly so, among women in the past. A culinary tradition, one seen today, emerged from this simple, though important, discovery about epazote and its value as a food additive. And the microbiological data identified in the third phase of our experimental trials confirmed the merits of this widely diffused and ancient custom. Kennedy (1978) was indeed correct—there are strong empirical reasons why it would be unthinkable to prepare black beans without epazote.

Hopefully the findings of this study will stimulate additional research on this small herbaceous plant originally domesticated in Mesoamerica thousands of years ago. The potential scientific and commercial applications of *C. ambrosioides* are considerable. This species certainly warrants further cross-disciplinary inquiry.

NOTES

[1] *C. ambrosioides* is a small (up to 1 m) herbaceous plant native to tropical and subtropical zones in the Americas, although it has naturalized to many other locales beyond its original range. It has been exported abroad and is now found in several countries in Africa, Asia, and Europe. The strongly scented leaves are alternate, lanceolate or oblanceolate in shape (ca. 4–12 cm long) with toothed, lobed, wavy, or smooth margins. It is known by at least fifty different common names, depending on the region and languages spoken. In English it is frequently called goosefoot or lamb's-quarters due to the shape of its leaves. The genus *Chenopodium* contains, worldwide, approximately 150 species. Some of these are of considerable cultural importance, especially in the Americas.

[2] These authors use a variant spelling, one common in Guatemala: "apazote."

[3] This setting on the incubator was chosen because it would simulate ambient daytime (noon) temperatures in much of Mesoamerica.

[4] Following an incubation period, three beans were placed in 10 ml sterile 0.75% NaCl, vortexed, serially diluted and plated in duplicate on tryptic soy agar (TSA). Plates were incubated at 30°C. Bacterial colonies were counted after 24 hours.

[5] Duke, Jim. n.d. Dr. Duke's Phytochemical and Ethnobotanical Databases. Agricultural Research Service, U.S. Department of Agriculture. [http://www.ars-grin.gov/duke/] (verified 9 December 2003)

[6] Ten µl of each compound was added to a sterile filter paper disk. The treated disk was placed on a lawn of bacteria obtained by spread plating one ml 10^5 bacteria/ml suspension on TSA plates. Bacteria tested included Gram-positive and Gram-negative organisms isolated from beans, *Salmonella* 8326, and *Bacillus* sp. isolates BA77, BA101, E21, E61, E65, E66, E69, E726, and E727. Cultures of *Bacillus* were obtained from the collection of Bonnie Ownley, University of Tennessee. After incubating 24 hours at 30°C, the diameter of cleared bacterial growth was measured. Cymene, limonene, and pinene were obtained from Aldrich Chemical, Milwaukee, WI. Myrcene, geraniol, safrole, ferulic acid, vanillic acid and ascorbic acid were obtained from Sigma Chemical, St. Louis, MO. Cymene, limonene, myrcene, geraniol, pinene, and safrole were used as concentrated oils. Ferulic acid and vanillic acid were suspended at 50 mg/ml in 95% ethanol and ascorbic acid was suspended at 100 mg/ml in distilled water.

[7] The anthelmintic activity of *C. ambrosioides* is due to the presence of ascaridole, which is known to be toxic to round worms (*Ascaris lumbricoides*), as well as a number of other parasitic organisms. Oil of Chenopodium was once widely used to expel intestinal worms, yet the dosage required to be totally effective approached the lethal limit in humans.

[8] Co-author Beth Maney, who is an avid horse breeder, found during our epazote tests that a water-based solution of *C. ambrosioides*, when applied daily as a wash to the soles of her horses' hooves, effectively eliminated hoof (thrush) infection from her animals. It proved superior to some common, over-the-counter, remedies designed to control this equine hoof infection.

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Plantago spp. AND *Bidens* spp.: A CASE STUDY OF CHANGE IN HAWAIIAN HERBAL MEDICINE

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ABSTRACT.—The substitution of alien species for native plants in Hawaiian traditional medicine is discussed. Substitutions examined are the switch from various native *Bidens* spp. to the more ubiquitous *Bidens pilosa* L. and the switch from the native plantains, *Plantago pachyphylla* A. Gray, *Plantago hawaiensis* A. Gray, and *Plantago princeps* Cham. and Schlechtend, to *Plantago major* L. Historical, cultural, and scientific data are synthesized to examine these changes in the traditional Hawaiian pharmacopoeia. Major elements that affect the inclusion of new plants in the Hawaiian pharmacopoeia are availability and biological activity. This process of inclusion also provides insight into how indigenous scientists adapt pharmacological traditions to the changing biological and cultural environment.

Key words: Hawaii, *la'au lapa'au*, ethnomedicine, *Bidens, Plantago.*

RESUMO.—A substituição de espécies introduzidas pelas plantas nativas na medicina tradicional do Havaí é debatida. As substituições examinadas são das espécies de *Bidens* nativas para *Bidens pilosa* e a substituição das *Plantago* spp. nativas, inclusive *Plantago pachyphylla, P. hawaiensis* e *P. princeps,* para *Plantago major.* Os aspectos históricos, culturais e científicos são sintetizados para examinar estas mudanças na farmacopéia tradicional do Havaí. Os dois elementos mais importantes na inclusão de novas plantas na etnofarmacopéia do Havaí são a facilidade de acesso das plantas e atividade biológico. Este processo ensina como cientistas indígenas adaptam tradições farmacológicos às mudanças nos meios biológico e cultural.

RÉSUMÉ.—Cette étude rend compte de l'utilisation d'espèces introduites aux dépens des plantes indigènes dans la médecine traditionnelle hawaiienne. La plante ubiquiste, *Bidens pilosa* L., ainsi que le *Plantago major* L., ont remplacé respectivement plusieurs *Bidens* spp. indigènes et les *Plantago pachyphylla* A. Gray, *P. hawaiensis* A. Gray et *P. princeps* Cham. et Schlecht. Afin de comprendre ces changements dans la pharmacopée traditionnelle hawaiienne, une synthèse des données historiques, culturelles, et scientifiques a été faite. Les principaux facteurs déterminant l'inclusion de nouvelles plantes dans la pharmacopée hawaiienne résident dans leur disponibilité et leur activité biologique. Également, ce processus d'inclusion permet de mieux saisir comment les «scientifiques autochtones» ont adapté leurs traditions pharmacologiques selon les changements survenus dans leurs environnements biologique et culturel.

INTRODUCTION

The purpose of this paper is to synthesize disparate cultural, historical and biological information to examine the factors that influence the adoption of *Bidens* *pilosa* and *Plantago major* into the traditional Hawaiian pharmacopoeia. Previous botanical, ethnobotanical, demographic, historical, and cultural research provides background on the plants, as well as their ethnobotanical history in Hawaii. Personal interviews let Hawaiians speak for themselves about the plants and the processes of adoption and substitution. A literature search of pharmacological tests as well as antibacterial screening offers insight into the comparative biological activity of the native and introduced species, an important factor in the introduction and use of a new plant species. Substitutions appear to be a result of a variety of cultural factors including empirical testing and observation to determine biological activity, spiritual inspiration, and other ecological considerations such as availability of plant material.

The Hawaiian Islands provides an excellent place for a study of the evolution of a pharmacopoeia because both its flora and traditional herbal medicine have been well studied. It is also significant that, even after the introduction of the western medical system in Hawaii, the traditional healing system has continued to be practiced and even expanded in recent years due to a Hawaiian cultural renaissance. Over the years, the traditional herbal medicine system (*la'au lapa'au*) has adapted to the changing biological and cultural environment. The substitution of *Bidens pilosa* L. and *Plantago major* L. for native species exemplifies this process.

A growing body of ethnobotanical research has begun to examine the origin and evolution of traditional medicine. For example, some recent research suggests that indigenous groups in pre-European contact America had much different pharmacopoeias than they do now, and the introduction of new diseases prompted the discovery of new plant medicines in the relatively short amount of time after the Europeans' arrival in the New World (Davis 1995). The simultaneous introduction of new diseases and new plants seems to potentially result in the expansion of medicinal plant use through scientific experimentation. Bennet and Prance (2000) found 216 post-European introduced plants that are a part of the indigenous pharmacopoeias of northern South America.

Other recent ethnobotanical studies illustrate how indigenous people experiment with plants. For example, around 40% of the plants in the local pharmacopoeia in 1995 were unknown to the sixteenth-century Portuguese settlers when they arrived in the Madeiras; they were either introduced from Africa or the Americas or were native to the islands (Rivera and Obon 1995). Similarly, Paul (2002) found that 40% of Haitian medicinal plants belong to genera that have similar medical uses in West Africa. This illustrates the tendency to adopt new species of the same genus when confronted with changed ecological conditions brought about by migration.

Some ethnobotanists focus on indigenous adaptations to these changed environmental circumstances. They theorize about the origins of a pharmacopoeia and the experimental processes by which new medicinal plants are selected. Moerman (1998) hypothesizes that plants used for medicine in traditional society will be those that are available, perennial, and widespread geographically, as well as easily noticed, large and distinctive. Perennials, especially larger tree species, live longer and thus generally have more secondary chemicals, making them more useful as medicinal plants. The other characteristics all have to do with the ease of finding and recognizing medicinal plants. Johns (1990) discusses the selection of new medicinal plants focusing on the methods by which biological activity of plants is discovered—including taste, odor, empirical testing, and the observation of animals.

Cox (1995) explains how Kuhn's (1965) work on scientific paradigms provides a method of understanding indigenous scientific processes. Indigenous healers operate in paradigms that differ from those of western science and these paradigms, in turn, direct the hypotheses and methodologies of indigenous experimentation (Cox 1995). Indigenous healers do, however, follow the scientific method, making observations, developing theories, and then using this knowledge and experience to predict future outcomes.

Origins and Evolution of the Hawaiian Pharmacopoeia.—In Polynesia, there is some debate about the origin of its herbal medicine tradition. Whistler (1992) has argued that Polynesians had a limited herbal medicine tradition, especially in relation to medicines taken internally. He shows that prior to European arrival, Polynesians had few infectious diseases, and as a result, the medical system was focused around external ailments such as wounds, sprains, rashes, and infections. More complex diseases were treated with spiritual healing, and the plants used in this process were "fetid herbal preparations applied externally or taken internally that were believed to have the power to repulse malicious spirits and to thereby heal" (Whistler 1992:37–38). Consequently, the complex Hawaiian medical system described by early native historians developed in the mid-nineteenth century in response to the introduced epidemic diseases and contact with medicine from European and other more developed herbal medical traditions, and "the widespread use of medicines for internal ailments that is so prevalent in Polynesia medicine today appears to have developed after, and as a result of, contact with the western world" (Whistler 1992:38).

Cox (1991), however, suggests that herbal medicine in Polynesia is a conservative tradition, in that most knowledge is gained from a mentor and not through experimentation (although he recognizes that new plant remedies are sometimes acquired in dreams). Cox extends these arguments to explain how Polynesian herbal medicine developed before western contact. He discounts early missionary histories relied on by Whistler and then supports this claim by noting the similarity between different medical traditions within Polynesia, the variation among different family traditions (a European introduced system would look more locally homogenous), Polynesian belief in the endemic nature of their healing traditions, and the fact that a majority of plants used medicinally in Polynesia are not used in other parts of the world.

Abbott and Shimazu (1985:220) comment that Hawaiians "have a tendency to stick to tried and true remedies," which mainly consist of plants the Polynesians carried with them throughout the Pacific. They note however, that many endemic plants are used, although less frequently, and that some plants introduced after European contact have also been added. This supports Cox's notion of the endemic origin of Polynesian herbal medicine based on similarities between different Polynesian pharmacopoeias.

Many of the processes observed in the evolution of traditional pharmacopoeias in other parts of the world apply to Hawaii. The introduction of infectious diseases and new plants, the migration of other ethnic groups to Hawaii, and the decreasing availability of native plant species all had an effect on the pharmacopoeia. The Hawaiian pharmacopoeia, like many others, has had rapid development and change in the number and species of plants used in the relatively short period since European contact. While this study does not directly address the origin of the Hawaiian pharmacopoeia nor the importance of Polynesian introduced plants to it, it does reveal some of the processes behind the introduction of new plants to Hawaiian herbal medicine, presenting a dynamic view of the evolution of the Hawaiian ethnomedical tradition.

Two methods for the discovery of new medicinal plants are evident in Hawaii: empirical practice and spiritual guidance. Handy describes the origins of medicinal plant usage in Hawaii,

> It will be plain to anyone that makes even a superficial study of Hawaiian medicine that the system has arisen mainly through empirical practice. . . . Many Hawaiians will tell you that the system has been established through a trial and error method, but that the original knowledge of the healing qualities of various elements used has always been, and is still, revealed by the ancestral *aumakua* [spirits] in dreams. Handy (1934:16)

Empirical practice is a research method based on experimentation and observation, much like the scientific method. According to Larsen (1946:19), ancient Hawaiians were "developing a system of medicine that was built upon observation, deduction, experimentation, and clinical trial," but that "this system was lost as their whole culture succumbed to the pompous tide of European conquest" (Larsen 1946:19). From the observations made in this paper it is clear that the experimentation, observation, and deduction in Hawaiian traditional medicine continued long after European conquest.

While this study focuses on the empirical processes behind the discovery of new medicinal plants, the spiritual roots of Hawaiian healing cannot be ignored: in Hawaiian healing traditions, spiritual guidance is an essential element in the discovery of new plant material. In the ethnoscientific paradigm of *la'au lapa'au*, dreams, visions, and inspired thoughts provide *la'au* practitioners with hypotheses from which they can begin the empirical testing process for new remedies (Cox 1995).

REVIEW OF THE ETHNOBOTANICAL AND BOTANICAL LITERATURE

Bidens spp.—The nineteen endemic *Bidens* species in Hawaii evolved through adaptive radiation from a single primal ancestor (Ganders 2000; Wagner et al. 1999). All the species are interfertile, but most do not occur sympatrically (Ganders and Nagata 1984). In modern times four species have been introduced: *Bidens pilosa* L., *B. cynapiifolia* Kunth, *B. alba* (L.) D.C., and *B. gardneri* Baker. *Bidens pilosa*, which first arrived sometime before 1845, is native to the tropical Americas (Wagner et al. 1999). *Bidens cynapiifolia* was first collected in 1929, almost seventy years later (Degener 3781 BISH), *B. alba* in 1958 (Pearsall s.n., BISH), and lastly *B. gardneri* in 1983 (Hobdy 1883 BISH). *Bidens alba* and *B. pilosa* are both widespread in low lying disturbed areas with *B. alba* becoming increasingly more abundant on Oahu (Wagner et al. 1999).

Generally, a distinction is made between native species of *Bidens,* called *ko'oko'olau* or *ko'olau,* and the non-native *B. pilosa,* which is called *kinehi.* However, there is still some ambiguity and *ko'oko'olau* can be used to refer to any species of *Bidens.* For example, Kaiahua identifies *ko'oko'olau* as *B. pilosa.* He also mentions that there are two kinds of *ko'oko'olau,* indicating that the term *ko'oko'olau* can be used to refer to more than one species (Kaiahua 1997). Comparing the use of native and introduced *Bidens* species is thus complicated because most texts make no attempt to distinguish among them. A source ascribed to Kupunihana, written around 1922, mentions three types of *ko'oko'olau* used as medicine for stomach ailments and numerous other ailments, indicating that many of the species within the genus were recognized and used medicinally (Chun 1998). None of the early texts, even into the early twentieth century, use the term *kinehi* (Chun 1994a, 1994b, 1998; Handy et al. 1934; Kaiakamanu and Akina 1922; Kamakau 1964).

Nineteenth-century sources on Hawaiian herbal medicine mention that *ko'oko'olau* is useful for asthma, throat and stomach troubles, stimulating the appetite, general debility of the body, childhood ailments, as a purgative (with other plants), and as a tonic (Chun 1994a; Kaaiakamanu and Akina 1922). All of the treatments that were common in precontact times are for ailments that are easily recognizeable (sore throat, general debility, stomach troubles). Thus, following Whistler's logic, they are more likely to have been treated with an herbal remedy during precontact times.

The earliest mention on *ko'oko'olau* in the literature is in 1866 in Kamakau (1964) and the 'Ahahui report in 1867 (Chun 1994a). After this, *ko'oko'olau* is mentioned in a number of other studies on Hawaiian herbal medicines (Chun 1994a, 1994b, 1998; Handy et al. 1934; Judd 1997; Kaiakamanu and Akina 1922; Kamakau 1964; McBride 1979), whereas *kinehi* is only mentioned in one published sources (Kaiahua 1997). This suggests the native species were more widely used until recently. *Ko'oko'olau* was also used to treat a wide variety of endemic health conditions, suggesting that the native plant has been used since before European contact. It would appear from the widespread use of *B. pilosa,* its early introduction, as well as the variety of *Bidens* species that are used, that *B. pilosa* has been in the pharmacopoeia for some time, even if the name *kinehi* appears only recently in the ethnobotanical literature.

Plantago spp.—The genus *Plantago* is a similar example of substitution. Multiple native and introduced species have been reported to have medicinal use. The taxonomy of endemic plantains, however, is much simpler. There are three endemic species: *Plantago hawaiensis* A. Gray, *P. pachyphylla* A. Gray, and *P. princeps* Cham. and Schlechtend. *P. pachyphylla* and *P. hawaiensis* appear to be more closely related to each other than to *P. princeps* (Wagner et al. 1999). There are five introduced species, including *Plantago major* and *P. lanceolata. P. major* is widespread throughout the Hawaiian Islands and was first collected in 1864–1865 (Mann and Brigham 423, BISH). *P. lanceolata* was first collected on Kauai in 1895 (Heller 2457, BISH). The other alien species are more recently introduced and less widely distributed (Wagner et al. 1999).

The Hawaiian generic name for *Plantago* is *laukahi.* The native species are referred to as *laukahi kuahiwi,* indicating that they are found in the mountains. The native species also have other names that differentiate between them, *manene* for *P. pachyphylla,* and *ale* for *P. princeps* (Wagner et al. 1999).

Laukahi is used as a purge for mother and babies, to draw the pus out of sores and boils, and to cure the diseases of *pa'ao'ao* and *'ea* (Chun 1994b, 1998) Other authors mention that *laukahi* is used as a tonic, a laxative, a poultice for boils and sores, and as a tea for diabetes, urinary tract infections, kidney problems, pulmonary disease, and high blood pressure (Gross 1998; Handy et al. 1934; Kaiahua 1997; Krauss 1979; Nagata 1970; Whistler 1992). Interestingly *laukahi* is used to treat ancient Hawaiian disease categories (*pa'ao'ao*) as well as more modern ailments (diabetes, high blood pressure) and external, internal, and 'spiritual' disease categories, suggesting that new plants are not just adopted to treat new diseases.

There is some disagreement on whether or not the native *Plantago* species were used in precontact Hawaiian herbal remedies. Krauss (1979, 1993, 2001) and Gross (1998) suggest that the introduced *P. major* replaced the native *Plantago* species while Whistler concludes that

> Several authors have reported that these native plantains were the original medicinal species and that the introduced weed *Plantago major* has replaced it, presumably because the latter is so common and easy to obtain. It is more likely, however, that *Plantago major* was the first and perhaps the only species commonly used in Hawaiian medicine. (Whistler 1992: 188)

Given the widespread medicinal use of *Plantago* throughout the world, this is plausible (Basaran 1996; Bayon 2000; Henderson 1994; Johnson 1999; Ramos 1996). A children's book on Hawaiian herbal medicine mentions that the Japanese, who migrated to Hawaii in large numbers, also use *Plantago major* in a similar manner to the Hawaiians (Corum 1985). Most of the immigrants who came to Hawaii arrived well before 1922 (Juvik and Juvik 1998), the date of the first study that specifically mentions and describes the medicinal use of *laukahi lauli'i* (clearly identifying *P. major*) (Kaaiakamanu and Akina 1922). This allows time for significant interaction between Hawaiians and new immigrants, supporting Whistler's (1992) claim.

However, in support of the use of native *Plantago* spp., the earliest reference to *laukahi* is found in Kamakau's writing about the people of old Hawaii. This work was published in a Hawaiian language newspaper series from 1866–1871, around the time the Chinese first immigrated but before they had moved throughout the Islands. Another early reference is found in a group of interviews conducted with a variety of healers in 1867 as part of the establishment of a native Hawaiian healers' organization (Chun 1994a). Five different healers all used *laukahi* in many different ways. One healer, Pupuka, even specifically mentions the use of *laukahi kuahiwi,* referring to one of the native species. These sources seem to confirm the early widespread use of *Plantago,* definitely including the native species and possibly *P. major.* The number of different people using *Plantago* spp.

and the early date of use all seem to indicate a switch from the use native *Plantago* spp. to the introduced *Plantago major.*

After this 1867 mention of *laukahi kuahiwi* there is no specific mention of the use of the native *Plantago* species besides Krauss (1979, 1993, 2001) and Gross (1998) (who mention it being replaced with *P. major,* not its contemporary use. Whenever *laukahi* is subsequently mentioned in research on Hawaiian herbal medicine it is always identified as *P. major* (Gross 1998; Handy et al. 1934; Kaiahua 1997; Kaiakamanu and Akina 1922; Krauss 1979; Nagata 1970; McBride 1979; Whistler 1992). Bushnell et al. (1950) suggest that *P. lanceolata* is also used as medicine, however, the source material he cites—Kaaiakamanu and Akina (1922)—does not support this assertion. This information, plus the conspicuous absence of current references to all other *Plantago* spp., strongly suggests that *P. major* is currently the only member of genus used in the Hawaiian pharmacopoeia and it probably replaced the use of the native species.

Antibacterial Assays for Bidens *spp. and* Plantago *spp.*—The widespread use of both *Bidens* spp. and *Plantago* spp. in traditional medicine has stimulated a significant amount of research on their biological activity (Table 1). These studies suggest a broad range of healing affects from both *Bidens* and *Plantago* species. *Bidens* has been screened for antibacterial activity, a treatment for liver diseases, and an anti-ulcer treatment; *Plantago* spp. has been tested for anti-inflammatory and wound-healing properties. Thus, the biological activity of both *Bidens* spp. and *Plantago* spp. is consistent with their uses in the Hawaiian pharmacopoeia, suggesting that Hawaiian healers possessed a sophisticated knowledge of biological activity.

The biological activity of *Bidens* is due to large classes of compounds: polyacetylenes and flavonoids.[1] Marchant et al. (1984) researched polyacetylene content in Hawaiian *Bidens* species and found a surprising array of different molecules in different species. While all contained polyacetylenes in their roots, thirteen species did not contain any polyacetylenes in their leaves, suggesting highly variable antibacterial activity within the native *Bidens* species. The native species *Bidens macrocarpa* (A. Gray) Sherff, *Bidens populifolia* Sherff, and *Bidens campylotheca* Schultz-Bip. all contained some level of polyacetylenes in their leaves, which indicates that the leaves have antimicrobial properties (Marchant et al. 1984).

METHODOLOGY

Interviews.—Semi-structured interviews were conducted with both specialists and nonspecialists.[2] The purpose of the research was explained and verbal consent granted. The participants were questioned about their knowledge of both introduced and native species of *Bidens* and *Plantago* and their uses and relative effectiveness, as well as possible reasons for the preference of one species over another. When possible, the plants were examined in the field or shown to the participants. In other cases, the plants were described with salient features to distinguish between species. All the species in question had some visible, easily distinguishable features (e.g., yellow versus white flowers, narrow versus rounded leaves).

Antibacterial Assays.—The selection the plants species for the antibacterial assays was dependent on locally available species. The introduced *B. pilosa, P. major,* and

TABLE 1.—A summary of some of the pharmacological studies done on biological activity of *Bidens* spp. and *Plantago* spp.

Plant	Study	Results
B. pilosa	Bushnell et al. 1950	Antibacterial—moderately effective; anti-enteric pathogens—moderately effective
	Wat et al. 1979	Polyacetelynes are phototoxic to bacteria and fungi
	N'Dounga et al. 1983	Antibacterial activity
	Machado et al. 1988	Antiparasitic activity
	Geissberger et al. 1991	Antihypertensive
	Sarg et al. 1991	Anti-ulcer activity
	Chih et al. 1995	Anti-inflammatory
	Gupta et al. 1996	Tumor inhibition; cytotoxicity; DNA intercalation; brine shrimp toxicity
	Jager et al. 1996	Prostaglandin-synthesis inhibition
	Chih et al. 1996	Protect liver injuries from various hepatotoxins and have antihepatic agents
	Alvarez et al. 1996	Antimicrobial; cytotoxic; insecticidal
	Rabe and Van Staden 1997	Antibacterial activity
	Brandao et al. 1997	Antimalarial
	Pereira et al. 1999	Immunosuppressant activity
	Dimo et al. 1999	Antimicrobial activity
	Alvarez et al. 1999	Antimicrobial; not antidiabetic
	Tan et al. 2000	Possible anti-ulcer effects
	Ubillas et al. 2000	Antihyperglycemic
	Dimo et al. 2001	Hypotensive effect
	Khan et al. 2001	Antimicrobial
	Chang et al. 2001	Possible treatment for leukemia
B. campylotheca	Redl et al. 1994	Anti-inflammatory active polyacetylenes
B. subalternans	Ortega et al. 1998	Anti-inflammatory
B. aurea	La Case et al. 1995	Anti-ulcer agent
	Martin et al. 1996	Anti-ulcer agent
B. alba	Lopez et al. 2001	Does not modify insulin or glucose levels

TABLE 1—(continued)

Plant	Study	Results
P. major	Bushnell et al. 1950	Antibacterial—moderately effective; anti-enteric pathogens—slightly effective
	Ravn and Brimer 1988	Anti-inflammatory and analgesic activity
	Dat et al. 1992	No diuretic activity
	Guillen et al. 1997	Component plantanajoside has possible antibacterial effects
	Ringborn et al. 1998	Anti-inflammatory; anti-ulcer by inhibition of COX-2 enzyme
	Michaelson et al. 2000	Possible wound healing effects
	Hetland et al. 2000	Polysaccharide fraction PMI protects against pneumococcal infection
	Ikawati et al. 2001	Inhibited IgE-dependent histamine; possible asthma or allergenic disease uses
P. lanceolata	Marchesan et al. 1998	Anti-inflammatory
	Deliorman et al. 1999	Hepatoprotective effects
	Schmidgall et al. 2000	Moderate activity on treatment of irritated buccal membranes.
P. asiatica	Tezuka et al. 2001	Anti-inflammatory

P. lanceolata were readily obtained from the lawns on the Brigham Young University-Hawaii campus while *P. pachyphylla* required long hike to the summit of the Ko'olaus. Similarly, many of the native *Bidens* species are rare and occur in small, localized populations (Wagner et al. 1999) although they are generally more common than the *Plantago* species. Voucher specimens were collected.[3]

For *Plantago* spp. the antibacterial screening portion of this study includes only one native species, *P. pachyphylla* (I was unable to collect *Plantago hawaiensis* and *P. princeps* because they are endangered species and have very limited distributions), and the introduced species of *P. major* and *P. lanceolata* (Wagner et al. 1999). For *Bidens* spp., the three native species endemic to the northeastern section of the Ko'olau Mountains—*Bidens populifolia, B. macrocarpa,* and *B. campyloptheca*—were screened along with the two most common introduced species—*B. pilosa* and *B. alba.*

An agar diffusion method (Ingraham and Ingraham 2000) was used to analyze the antibacterial properties of native *Bidens* in comparison with the introduced species, and the native *Plantago pachyphylla* in comparison with the introduced *P. major* and *Plantago lanceolata.*

All eight plants were tested against *Staphylococcus aureus* and *Escherichia coli* bacteria. These microorganisms were used because they are common skin and digestive tract microorganisms and correspond with Hawaiian uses of *Bidens* and *Plantago* spp. They also offer examples of Gram-negative and Gram-positive bacteria and are common test organisms, allowing for comparison with other antibacterial studies. (Bushnell et al. 1950; Locher et al. 1995).

Fresh plant material including leaves and stems was blended and squeezed with a garlic press to obtain the plant extract. One or more plants were used depending on the amount of liquid extracted per plant. However, all plants of a given species used for antibacterial assays as well as separate voucher specimen were collected from the same site. No solvent was added. Plant extract (0.75 ml) was applied to a 3-mm diameter paper disk. The paper disk was placed in a petri dish of Mueller-Hinton agar inoculated with either the *Escherichia coli* (Migula 1895) Castellani and Chalmers 1919 or *Staphylococcus aureus* Rosenbach 1884. Each dish contained both positive and negative controls—a commercially prepared antibiotic disk (Erythromycin) and a blank paper disk. Five plates were prepared for each plant to be tested. The petri dishes were incubated for 24 hours at 37.5°C. The zone of inhibition was then measured in millimeters.

It is important to note that an agar diffusion method does not offer a complete picture of the multiplicity of possible medicinal effects of the plants such as the potential interactions of plant compound in a living system or in conjunction with other plant mixtures. It does, however, offer some insight into the comparative biological activity against certain bacteria.

RESULTS AND DISCUSSION

Interviews.—Personal interviews, including those with both healers and nonhealers, provided the most important source of information regarding the introduction of new plants into the Hawaiian pharmacopoeia. Today, *kinehi* (*B. pilosa*) and *ko'oko'olau* (native *Bidens*) are used topically to cleanse wounds, heal sunburns and insect bites, and to strengthen the body (often in conjunction with more powerful traditional medicine). While the names for the various species of *Bidens* are sometimes used interchangeably, all of the people interviewed, healer and nonhealers, knew about the use of *Bidens* and recognized the difference between the native and introduced species, even if they had never used the native species.

Students of the late Papa Auwae, a well-known *la'au lapa'au* practitioner, described how he taught that *kinehi* is more potent than the native *ko'oko'olau* and is useful in treating a wider variety of illnesses. The *ko'oko'olau* is used as a general tonic, whereas *kinehi* is used to treat all manner of internal ailments. He also taught that the potency of the different *Bidens* populations is also dependent on the location from which the plant was gathered, possibly indicating a much more sophisticated knowledge of bioactivity of *Bidens*.[4] Another interview suggests that the plants were mixed to achieve various effects and possibly to control the potency. Some people prefer *kinehi* or *ko'oko'olau* because of taste and custom. Taste, however, may also be an indicator of biological activity (Johns 1990). This suggests that people recognize the differences in biological activity among different species, which is an important factor in favoring the use of one species over another and the adoption of new plants into the pharmacopoeia.

Authors on contemporary *la'au lapa'au* practices most often cite availability as the reason for the introduction of new plants into the herbal medicine tradition (Judd 1997; Krauss 1979). Krauss (1979) specifically mentions that *kinehi* is used in place of the native *ko'oko'olau* because of its availability. People interviewed also indicated that availability was an important factor in the decision to use the introduced plants. Many people using traditional medicine are aged and are unwilling to hike into the mountains to find the native *Bidens* and *Plantago* species, especially when a similar plant is growing in their front yard. Plants, especially those with healing properties, are seen as gifts from God, and it makes sense that God would make a useful plant readily available. Personal experience while gathering plants on Oahu for this project also supports the idea that the introduced plants are much more readily available. This is due, in part, to the degradation of native ecosystems. Native plants are limited to small areas higher up in the mountains (Juvik and Juvik 1998).

In sum, in the case of *Bidens,* there is no simple substitution. The reality is much more complex. Both native and introduced species are still used, sometimes together, and the decision to use one or the other is based on the availability, biological activity, disease to be treated, personal preference (taste), and familiarity with the plant.

Although the use of *P. major* is widespread, there is no use and little knowledge of any of the native *Plantago* species. The literature about contemporary *la'au lapa'au* practitioners does not mention the native species (Judd 1997; Kaiahua 1997; McBride 1979). While Krauss and Whistler comment on the switch from the native to the introduced *Plantago* (Krauss 1979, 1993; Whistler 1990), people interviewed for this study did not recognize the medicinal uses of the native *Plantago* species. The rarity of the native species compared to the ready availability of *P. major* seems to account for the complete substitution of the native *Plantago* species with *P. major.*

Another important lesson learned from Hawaiian *la'au* practitioners is that the spiritual component of healing is absolutely essential. Four people mentioned that 80% of healing is "spiritual" while only 20% comes from the biological activity of the plants. In addition, plants are seen as gifts from God to aid in the healing process, so it could be said that all healing comes from God. Furthermore, divine inspiration is an essential source of knowledge about new medicinal plants. There are stories of people being inspired to use a new plant that they had never used medicinally before. This seems to be a common local explanation for the addition of new plants into the pharmacopoeia.

Antibacterial Assays.—In the case of *Bidens,* both native and introduced species have antibacterial activities. The most activity was found in *B. macrocarpa* and *B. pilosa.* While the native species all exhibit some antibacterial activity, there is quite a bit of variability between the different species (Table 2). A study comparing *B. campylotheca* to *B. pilosa* for antimalarial activity found both to have antimalarial activity with *B. pilosa* being more effective (Brandao et al. 1997). This correlates with native Hawaiian perceptions of comparative biological activity of the native *Bidens* spp. and *B. pilosa.* The decline in use of the native species may be a function of the variable antibacterial activity (depending on the species) as well as decreasing availability. *Bidens alba,* although readily available on Oahu (more so than any other *Bidens* species), is rarely used medicinally. Its moderate antibacterial activity suggests that this maybe a function not only of its recent introduction to Hawaii but also its moderate biological activity. Although this study did not include alternative *Bidens* extracts (e.g., methanol, ethanol, EtOAc, petrol, CH_2Cl), it is important to note that other tests that have included them have shown significantly greater antibacterial activity (Jager et al. 1996; Khan et al. 2001; Rabe and van Staden 1997).

Initially, it was not possible to detect variable antibacterial activity among the native and introduced *Plantago* spp. Given that native preparations of *Plantago major* usually include rock salt and that pharmacological studies of *Plantago* spp. found significantly more activity with methanol extracts (Guillen et al. 1997; Tezuka et al. 2001), salt and methanol extracts of *P. major* were made and tested. However, still no antibacterial activity was found (Table 3). It is possible that the strains of bacteria have developed some kind of resistance to certain antibacterials or that the chemical constituents of *P. major* vary between different populations depending on environmental and/or genetic conditions. Other kinds of biological activity besides antibacterial (anti-inflammatory, wound healing effects, etc.) could also explain the use of *Plantago* spp. in the Hawaiian pharmacopoeia. The widespread use of a variety of *Plantago* species in ethnomedical traditions throughout the world (Bayon 2000) and previous pharmacological studies suggest that *P. major* and the *Plantago* genus (possibly including the endemic Hawaiian species) are biologically active.

CONCLUSION

Substitutions and additions of *Plantago* and *Bidens* species to the Hawaiian pharmacopoeia appear to be the result of myriad intermingled biological and cultural factors. This study indicates that some of these elements could include:

TABLE 2.—Comparative antibacterial activity of native and introduced *Bidens* species.

	Native		Introduced		
	B. macrocarpa	*B. campylotheca*	*B. populifolia*	*B. alba*	*B. pilosa*
E. coli					
Plant	9.8 ± 0.2 (n = 5)	8.0 ± 0.8 (n = 4)	— (n = 5)	16.3 ± 9.4 (n = 3)	8.0 ± 1.1 (n = 5)
Erythromycin	17.4 ± 0.4 (n = 5)	17.8 ± 1.0 (n = 5)	16.8 ± 0.7 (n = 5)	14.0 ± 1.0 (n = 5)	16.2 ± 1.1 (n = 5)
S. aureus					
Plant	7.0 ± 0.4 (n = 5)	3.2 ± 0.2 (n = 4)	4.5 ± 1.5 (n = 2)	3 (n = 1)	8.8 ± 0.4 (n = 5)
Erythromycin	14.0 ± 0.3 (n = 5)	11.6 ± 1.1 (n = 5)	10.4 ± 1.7 (n = 5)	12.2 ± 0.7 (n = 5)	11.0 ± 0.3 (n = 5)

Antibacterial activity indicated by radii of the rings of inhibition measured in millimeters; not detected (—): for all five runs rings of inhibition measured <0.5 mm.

Five trials were undertaken for each plant. Whenever one or more trial was unsuccessful (ring of inhibition <0.5 mm), that trial was not included in the statistical assessment; rejected data of this kind are indicated by the n value.

TABLE 3.—Comparative antibacterial activity of native and introduced *Plantago* species.

	Native	Introduced	
	P. pachyphylla	*P. major*	*P. lanceolata*
E. coli			
Plant	— (n = 5)	— (n = 5)	— (n = 5)
Erythromycin	16.0 ± 0.5 (n = 5)	16.0 ± 1.5 (n = 5)	17.2 ± 0.4 (n = 5)
S. aureus			
Plant	— (n = 5)	— (n = 5)	— (n = 5)
Erythromycin	10.2 ± 0.4 (n = 5)	10.5 ± 1.4 (n = 4)	10.8 ± 0.9 (n = 5)

Antibacterial activity indicated by radii of the rings of inhibition measured in millimeters; not detected (—): all five runs rings of inhibition measured <0.5 mm.
Five trials were undertaken for each plant. Whenever one or more trial was unsuccessful (ring of inhibition <0.5 mm), that trial was not included in the statistical assessment; rejected data of this kind are indicated by the *n* value.

availability of the introduced and native plants, often as a result of environmental degradation; biological activity of the plant; and a variety of cultural factors, including the spiritual component of traditional Hawaiian healing, interaction with different immigrant groups, time of introduction, familiarity with a plant, and taste preference. Conversations with local Hawaiians about *Bidens* confirm these observations, which are also supported by the pharmacological literature, studies of modern Hawaiian ethnobotany, and other ethnobotanical literature that discusses the adoption of introduced plants into a pharmacopoeia.

If availability of a species is essential for its inclusion in a pharmacopoeia, then it becomes increasingly important to preserve the environments where indigenous people live and gather medicinal plants so that cultural knowledge about plant use may be preserved. If indigenous medicinal plants are not available, local healers will replace them with plants that are.

These conclusions about availability and biological activity of *Bidens* and *Plantago* in Hawaii are consistent with existing theories of medicinal plant selection. As Moerman (1998) suggests, the plants adopted are abundant (available), widespread geographically, and distinctive. (Although, contrary to Moerman's theories, neither species is very large nor perennial.) Abundant and widespread geographically, weed species (such as *B. pilosa* and *P. major*) are often highly competitive because they have high concentrations of active chemicals. This suggests that the factors that allow for their abundance and worldwide distribution also make them biologically active and thus effective medicine. Johns's (1990) work discussing indigenous observation and methodological techniques for selecting biologically active plants is also relevant to the discussion on how the Hawaiians selected plants with biological activity. Interviews with local Hawaiians illustrates that native healers are knowledgeable about comparative biological activity.

Whistler (1992), Davis (1995), Rivera and Obon (1995), Bennet and Prance (2000), and Paul (2002) all show the dynamic interaction of ethnomedical systems with both the physical and cultural environment—how indigenous scientists experiment and adapt to meet the demands of changing social and environmental systems. While all of these studies mentioned the rapid adoption of new plant species when people are introduced into a new environment, Paul's (2002) work is interesting in that it supports the notion that new species of the same genera as known medicinal plants are more likely to be adopted into the indigenous pharmacopoeia. This research on *B. pilosa* and *P. major* supports that hypothesis; both plants could have been added because of the previous use of a similar plant in the precontact Hawaiian pharmacopoeia.

Whistler (1992) and Davis (1995) imply that the introduction of new disease, subsequent population decline, and other factors that accompany contact with European cultures encourage the addition of new plants to indigenous pharmacopoeias. This study, by examining two plants apparently adopted around 100–150 years ago, generally supports this hypothesis. However, it appears that neither *P. major* and *B. pilosa* were adopted to treat introduced diseases. A more general study looking at all the introduced species in the Hawaiian pharmacopoeia would be more appropriate to evaluate the larger effects of introduced diseases and migration on the pharmacopoeias.

While this research does not directly address the origin of the Hawaiian and Polynesian pharmacopoeias, the emphasis on the indigenous scientific process suggests that traditional herbal medicine did not arise solely after western contact. It suggests, rather that traditional knowledge of medicinal plants has a long history in Polynesia but was profoundly affected by the cultural, biological, and ecological changes that occurred with the arrival of Europeans in Polynesia.

Thus the discussion started by Cox (1991, 1995) becomes particularly important. The paradigm provides the pertinent questions and hypotheses that any group of scientists consider relevant. Science becomes the process of inquiry rather than the technological product. Ethnobiological research should, in realization of the importance of scientific paradigms, focus on understanding these processes. Studying the adoption of these introduced plants into the Hawaiian ethnopharmacopoeia, we can clearly observe the spiritual, pragmatic, active, and empirical processes involved in the science of *la'au lapa'au.*

By focusing on the introduction of two specific plants this paper clearly describes some of the processes behind substitutions. By studying plants that have been recently added to indigenous pharmacopoeias, insight is gained into the methodology of indigenous healers. This has significant implications for viewing ethnobotanical knowledge as dynamic and active in the context of cultural change. On a larger scale, examining the nature of change in Hawaii helps to understand the processes that continue to happen throughout the world as ecosystems are degraded and pharmacological traditions adapt to the changing realities of the twenty-first century.

NOTES

[1] Dharmananda, Suhhuti. n.d. A popular remedy escapes notice of Western practitioners. [www.itmonline.org/arts/bidens.htm] (verified September 2003).

[2] Interviews were carried out from January to April 2002. Having been raised in Ko'olauloa,

some of the people interviewed were already acquaintances. Through those I already knew I branched out and found others they recommended as having some knowledge about Hawaiian medicinal plants. The only people who considered themselves healers and who have active herbal medical practices were Bula Logan and Alapa'i Kahu'ena. The other interviews were with people who had widely differing experience with medicinal plants (personal experience while growing up, some formal training, etc.): their recollection and knowledge of the plants and their uses varied greatly. The participants were generally between 30 and 60 years old. Those interviewed were Gladys Ahuna, Millie Enos, Kawika Eskeran, Alapa'i Kahu'ena, Norman Kaluhiokalani, Bula Logan, Henry Na'awao, Howard K.K. Pali, Harold H. Pukahi, Rueben H. Pukahi, Kapua Sproat, Ipolani Thompson, Kamo'a'e Walk, and William Wallace. I would like to thank all of the people above who shared their knowledge and time in order help me better understand and appreciate *la'au lapa'au*.

[3] Voucher specimens were collected and identified by Clyde Imada at the Bishop Museum Herbarium and were deposited at the Waimea Arboretum and Botanical Gardens, 59-864 Kamehameha Hwy, Haleiwa, Hawaii 96712.

[4] Several of the people interviewed including Alapa'i Kahuena, Kapua Sproat, and Norman Kaluhiokalani had studied for some time under a well know Hawaiian healer, Papa Auwae. Much of what they knew came from their experiences with him.

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NOMENCLATURE OF BREADFRUIT CULTIVARS IN SAMOA: SALIENCY, AMBIGUITY, AND MONOMIALITY

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ABSTRACT.—Breadfruit is an important subsistence crop in the Samoan archipelago, where numerous cultivars are grown and used. The diversity of breadfruit in Samoa is indicative of its antiquity and value to this society. The purpose of our study was to document and compare knowledge of breadfruit names by Samoans of a wide range of ages in both rural villages and towns and to test the relationship between saliency and binomiality. A total of 354 people were interviewed and 46 cultivar names were recorded. A binomial is used to name a breadfruit—the generic term ***'ulu*** is given first and a second word is added to describe that particular cultivar—when the second word used alone could refer to something other than breadfruit. A monomial is used only when this term does not refer to anything else or has no other meaning. There was no significant relationship between saliency and binomiality of breadfruit names and a significant relationship between binomiality and linguistic ambiguity. A useful outcome of this study was defining 60 Samoans as "experts" with statistical measures that we will use in continuing ethnobotanical studies in Oceania and that may have broader application.

Key words: breadfruit, *Artocarpus altilis,* Samoa, tropical crop cultivars, ethnotaxonomy.

RESUMEN.—El árbol del pan es un cultivo importante para la subsistencia en el archipiélago de Samoa, donde se cultivan y utilizan numerosas variedades. La diversidad de árboles del pan en Samoa es indicativa de su antigüedad y valor para esta sociedad. El propósito de nuestro estudio era documentar y comparar el conocimiento de los nombres de variedades de los árboles del pan entre Samoanos de una amplia gama de edades en aldeas y pueblos rurales y examinar la relación entre la importancia cultural y utilizacíon de binomios. Se entrevistó un total de 354 personas y se registran 46 nombres de variedades. Se utiliza un binomio para denominar un cultivar de árbol del pan—al término genérico ***'ulu*** y se le agrega una segunda palabra para describir ese cultivar particular—cuando al utilizar la segunda palabra sola podría entenderse algo distinto a los árboles del pan. Se utiliza un monomio solamente cuando este término no se refiere a ninguna otra cosa ni tiene ningún otro significado. No encontramos ninguna relación significativa entre la importancia cultural y la utilizacíon de binomios y la ambigüedad lingüística. Durante este estudio utilizamos medidas estadísticas para definir a 60 Samoanos como "expertos." Esta técnica servirá para la continuación denuestros estudios ethnobotánicos en Oceanía y pueden tener una aplicación más amplia.

RÉSUMÉ.—L'arbre à pain demeure une espèce importante en agriculture de subsistance dans l'archipel de Samoa, où de nombreux cultivars sont utilisés et cultivés. La diversité de l'arbre à pain en Samoa est un indice de son antiquité et de son importance pour cette société. Le but de notre étude était de documenter et de comparer la connaissance portant sur les noms de l'arbre à pain parmi les Samoans provenant d'un large éventail d'âges et issus autant des villes que des villages ruraux. Le rapport entre l'importance culturelle et la binômialité a été vérifié. Un total de 354 personnes ont été interviewées et 46 noms de cultivars ont été enregistrés. Un binôme est employé pour désigner un arbre à pain: le terme générique «*'ulu*» est donné d'abord, puis un deuxième mot est ajouté pour décrire ce cultivar particulier. Le deuxième mot utilisé seul pourrait cependant se référer à autre chose que l'arbre à pain. Un monôme est employé seulement lorsque ce terme ne se rapporte pas à autre chose ou n'a aucune autre acception. Nous n'avons trouvé aucun rapport significatif entre l'importance culturelle et la binômialité des noms de l'arbre à pain, mais il existe un rapport significatif entre la binômialité et l'ambiguïté linguistique. Des mesures statistiques ont été utilisées afin de qualifier «experts» 60 Samoans. Cette approche nous sera utile lors de nos prochaines études ethnobotaniques en Océanie. Elle pourrait avoir de plus larges applications.

INTRODUCTION

Agricultural people throughout the world typically recognize and name numerous forms or varietals of important domesticated plant species. These folk specific taxa are typically distinguished by subtle morphological differences such as color, relative size, shape, habit of growth, etc. (Berlin 1992). Culturally salient plants—those species and cultivars that are well known throughout a culture and are easily recognizable—have been the subject of much discussion and debate (e.g., Atran et al. 1997; Berlin 1986, 1992; Brown 1985, 1986, 1987). It has been suggested that highly salient taxa should be named with a monomial (Berlin 1992), while the greater specificity possible in a binomial should be used to distinguish closely related taxa, especially cultivars of domesticated plants (Hays in Brown 1985). This idea is roughly analogous to the use of short telephone numbers in Western societies to refer to highly salient services, such as 911 for the Police or 411 for Information, while longer numbers are used to distinguish between the numerous Jones families that appear in the telephone directory.

In this paper, a data set of 350 interviews with Samoans concerning knowledge of breadfruit names is statistically analyzed. We wanted to see if there are general patterns in the names applied to breadfruit cultivars, such patterns being a component of folk taxonomy in general (Berlin 1992), in an effort to determine both consistency and hierarchical diversity in the folk nomenclature of breadfruit in Samoa.

The Samoan archipelago lies in the central south Pacific Ocean. It is divided into two political entities: the independent nation of Samoa (formerly Western Samoa, which changed its name in 1997) with the principal islands of 'Upolu and

FIGURE 1.—*Ma'afala*, a common Samoan breadfruit cultivar, growing by a residence in Saipipi Village, Savai'i. Photograph by Diane Ragone.

Savai'i, as well as two smaller inhabited islands, Manono and Apolima. The easternmost islands are part of American Samoa, an unincorporated territory of the United States, comprised of five inhabited volcanic islands (Tutuila, Aunu'u, and the Manu'a Group of Ofu, Olosega, and Ta'u), and two coral atolls (Swains Island and the uninhabited Rose Atoll).

Breadfruit, *Artocarpus altilis* (Parkinson) Fosberg (Moraceae), is an important subsistence food crop in Samoa and trees are grown around residences (Figure 1) in all villages and in the towns (Ragone 1997; Whistler 2000). A census in 1989 estimated that 89 percent of agricultural households grew breadfruit and an estimated single crop equivalent area of 1000 ha of land was in cultivation (Ward and Ashcroft 1998). An aboriginal introduction, breadfruit has been an important component of Samoan subsistence agriculture for more than three millennia as part of a suite of crops that includes coconuts (*Cocos nucifera* L.), bananas (*Musa* sp.), taro (*Colocasia esculenta* (L.) Schott and *Alocasia macrorrhiza* (L.) D. Don), yams (*Dioscorea* sp.), ***'ava*** (*Piper methysticum* Forst. f.), and sugarcane (*Saccharum officinarum* L.).

Names, and in some cases descriptions, for as many as 30 Samoan breadfruit cultivars have been recorded by various visitors to Samoa since the 1840s (Ragone 1995). Cultivars are recognized and distinguished based on various morphological characters such as fruit shape and size, skin texture, flesh color, presence of seeds, leaf shape (especially degree of dissection or lobing), and tree form, or by fruit attributes related to cooking or storage qualities (Ragone 1997). The purpose of this study was to document and compare knowledge of breadfruit names by females and males of a wide range of ages in both rural villages and towns in Samoa. Our intent is to contribute not only to an understanding of breadfruit names in Samoa, but also to test the relationship between cultivar saliency and binomiality.

METHODS

Interview Techniques.—In July 2000, 354 Samoans in Samoa and American Samoa were interviewed about their knowledge of breadfruit names. Seven villages or towns were chosen for study: in independent Samoa, Saipipi and Falealupo on Savai'i and Apia (the capital city) on 'Upolu; and in American Samoa, Olosega and Ofu, Manu'a Group, Pago Pago (the capital city) and Afono on Tutuila Island. The interviews were conducted in the Samoan language by two-person teams and the responses were recorded on a standard form. In each village the teams walked to dwellings and work areas, interviewing any person who agreed to be interviewed. Interviews were conducted in homes, markets, and other areas of work and transit in the towns. In addition to residents, several expatriate Samoans from New Zealand and the United States who were visiting their families were interviewed. The age, date and place of birth, gender, occupation, place of residence, and marital status of each person interviewed were recorded. Each person was asked to name as many different cultivars of breadfruit as they could, together with information about local availability of each cultivar. The names were then read back to the respondent to ensure accuracy and to provide them with the opportunity to add any additional names.

One group interview with 43 Samoan chiefs (***matai***) was conducted during a chief's council meeting after an ***'ava*** ceremony in Falealupo, Savai'i. In addition, 16 individuals in Apia with conservation management responsibilities in government or NGOs (nongovernmental organizations) were interviewed. The latter 16 interviews were not pooled with the rest of the data to allow a comparison between the two data sets.

Several of the respondents, particularly those deemed by our statistical procedures to be "experts" (see below), were interviewed at length to elicit detailed information about uses, cultivation practices, descriptions, and naming rules or patterns of rules used to name breadfruit cultivars, but these data are not reported here. Voucher specimens of breadfruit cultivars were collected and deposited at the National Tropical Botanical Garden (PTBG).[1]

Recording of Data; Definitions of Idiosyncratic and Expert Respondents.—Interview data were entered into a spreadsheet on a portable computer in the field and grouped according to village. The breadfruit cultivar names recorded in the interviews were ranked by order of frequency of mention (Table 1). Breadfruit names in Samoa consist of either a binomial composed of a generic level term ***'ulu*** modified by a specific epithet or a monomial in which only the specific level epithet is used and ***'ulu*** is understood. If there was variation in the binomial or monomial form of a breadfruit cultivar name, e.g., ***ma'afala*** and ***'ulu ma'afala***, the form used by the majority of the respondents was selected. Where there were slight differences in spellings or pronunciations, a standardized spelling/pronunciation used by the

TABLE 1.—Frequency of breadfruit cultivar names recorded during interviews with 350 Samoans.

Cultivar name	Number of respondents[a]		%	Rank[b]	Type of name[c]	Translation[d]
ma'afala	(308)	315	90	1	UM	—
'ulu ma'afala	(7)					
puou	(283)	286	81	2	UM	—
'ulu puou	(3)					
aveloloa		238	68	3	UM	—
maopo	(214)	218	62	4	UM	—
'ulu maopo	(4)					
'ulu ma'a		195	56	5	AB	rock, hard[3]
'ulu ea	(185)	194	55	6	AB	Uvea Island[2]
'ulu uea	(9)					
'ulu manu'a		131	37	7	AB	Manu'a Islands[2]
momolega		116	33	8	UM	egg yolk[1]
'ulu sina	(79)	80	22	9	AB	white[1]
'ulu asina	(1)					
sagosago	(55)	59	17	10	UM	—
'ulu sagosago	(4)					
peti	(42)	56	16	11	AM	fat[1]
'ulu peti	(14)					
'ulu tala	(51)	54	15	12	AB	spiny[1]
'ulu talatala	(3)					
fia puou	(34)	38	11	13	UM	wants to be a *puou*[4]
fa'a fia puou	(3)					
'ulu fia puou	(1)					
'ulu fefelo	(22)	33	9	14	UB	—
fefelo	(11)					
'ulu initia		29	8	15	AB	India breadfruit[2]

TABLE 1—(continued)

Cultivar name	Number of respondents[a]		%	Rank[b]	Type of name[c]	Translation[d]
'ulu fau		26	7	16	AB	fibrous[3]
mase'e	(21)	23	7	17	UM	—
'ulu mase'e	(2)					
'ulu se'e		19	5	18	AB	sliding[3]
'ulu kiripati/kilipati		11	3	19.5	AB	Gilbert Islands[2]
gutufagu	(9)	11	3	19.5	UM	neck of the bottle[1]
'ulu gutufagu	(2)					
puou fatu		10	3	21	UM	seedy ***puou***[1]
'ulu falaoa		8	2	22	AB	loaf of bread[1]
vasivasi	(5)	6	1	23	UM	—
'ulu vasivasi	(1)					
puou tala		5	1	24	UM	spiny ***puou***[1]
'ulu fiti		4	1	26	AB	Fiji[2]
tui tu		4	1	26	AM	spiny[1]
fia maopo		4	1	26	UM	wants to be ***maopo***[4]
puou maopo		3	1	28.5	UM	***puou*** that looks like ***maopo***[4]
maualuga		3	1	28.5	AM	high[5]
'ulu faga		2	1	31	AB	eel trap[1]
malali		2	1	31	AM	smooth[1]
matatetele	(1)	2	1	31	AM	big eye[1]
'ulu matatetele	(1)					
ma'afala tala		1	0	39.5	UM	spiny ***ma'afala***[1]
puou tutunu		1	0	39.5	UM	roasting ***puou***[3]
'ulu toso		1	0	39.5	AB	pull[6]
'ulu to'elau		1	0	39.5	AB	Tokelau Islands[2]
'ulu tau		1	0	39.5	AB	pluck[6]

TABLE 1—(continued)

Cultivar name	Number of respondents[a]	%	Rank[b]	Type of name[c]	Translation[d]
'ulu sasalapa	1	0	39.5	AB	custard apple[1]
puou fefelo	1	0	39.5	AM	***puou*** that looks like ***fefelo***[4]
'ulu fagaloa	1	0	39.5	AB	Fagaloa village[2]
avesasa'a	1	0	39.5	UM	—
'ulu pase'e	1	0	39.5	AB	lazy[6]
'ulu mama	1	0	39.5	AB	light weight[3]
segatoa	1	0	39.5	UM	—
po'eloa	1	0	39.5	UM	—
fia ta	1	0	39.5	AM	wants to be slashed[6]

[a] Number of respondents (in parentheses) who listed a binomial or monomial variant of name.
[b] Ties are scored by using the average of the ranks of tied numbers, e.g., (19 + 20)/2 = 19.5, S(33:46)/14 = 39.5.
[c] Binomial/Monomial names as identified by Samoans. UM = unambiguous monomial, AM = ambiguous monomial, AB = ambiguous binomial, UB = unambiguous binomial.
[d] Definition of the different names of breadfruit cultivars. 1 = appearance, 2 = putative origin, 3 = culinary properties, 4 = comparative, 5 = respect term, 6 = descriptive action involving breadfruit. See text for explanation of categories.

TABLE 2.—Examples of Samoan breadfruit cultivar monomials and binomials.

	Generic term	Specific modifier
Binomial	***'ulu***	***sina***
Binomial with respect term	***fa'atau***	***sina***
Monomial	Ø	***ma'opo***
Monomial with two words in specific epithet	Ø	***fia puou***

Ø—generic term is understood.

majority of the respondents, e.g., ***'ulu ea*** and ***'ulu uea***, was adopted.[2] In these cases, the names were scored together for statistical purposes.

Before analyzing the data, idiosyncratic responses and interviews were removed and expert respondents were identified. A breadfruit name was regarded as idiosyncratic if it was mentioned by only one respondent, unless that respondent was an expert as defined below. The interview of any respondent who mentioned two or more idiosyncratic taxa was also defined as idiosyncratic. Idiosyncratic names and interviews were excluded from the statistical analyses. An expert was defined as any individual who reported a number of breadfruit cultivars equal to or greater than one standard deviation above the mean number of names reported by all respondents, and whose reported names included 90% of the cultivars that were known by at least half of all respondents.

Each breadfruit name was scored as an ambiguous monomial (AM), unambiguous monomial (UM), ambiguous binomial (AB), or unambiguous binomial (UB). This was accomplished by comparing the name to two comprehensive dictionaries of the Samoan language (Milner 1966; Pratt 1911) and by checking with two bilingual speakers of English and Samoan. A name was regarded as ambiguous if it conceivably could refer to an object other than breadfruit. This concept of using the term ***'ulu*** to prevent ambiguity or misunderstanding was posited by one of the ***matai***[3] when asked to explain how breadfruit cultivars are named and why some include the term ***'ulu*** and others do not. The example he gave to make this clear was, "If I ask one of the young men to 'Go get a ***ma'a***' he'll probably bring back a stone, but if I say 'Go get an ***'ulu ma'a***' he knows exactly what I'm asking for, whereas if I say 'Go get a ***ma'afala***', it is absolutely clear that I want a certain type of breadfruit. It wouldn't be necessary to say 'Go get an ***'ulu ma'afala***'." We here use the terms "ambiguous" and "unambiguous" as contrast terms rather than Berlin's (1992) terms of "analyzable/unanalyzable" for the sake of simplicity, and because "ambiguous" and "unambiguous" are direct translations of the Samoan terms "***manino***" and "***le manino***" respectively.

RESULTS

Interviews.—Breadfruit cultivar names in Samoa consist of either a binomial composed of the term ***'ulu*** modified by a descriptive term (Table 2), or a monomial in which only a descriptive term is used and ***'ulu*** is understood. This understanding was made explicit to us by several respondents, who, if questioned intensely or if they thought we were naive, would add the term ***'ulu*** to the description to emphasize that they were indeed referring to a cultivar of breadfruit. Samoan, as is the case with many languages that did not have an indigenous orthography, often uses a series of two or more words to express a single concept. Consequently, monomials can also sometimes be expressed as several words that form a coherent epithet or descriptive phrase. All persons interviewed used the generic level term ***'ulu*** for breadfruit, with the single exception of the village of Tafua, Savai'i. Because the Samoan language of politeness taboos the use of a word if it is a chief's name, it may not be used in the presence of the chief holding the name as a title (Pratt 1911). Out of deference for the paramount chief 'Ulu Taufa'asisina, the respect word for breadfruit, ***fa'atau***, is always substituted for the term ***'ulu*** in this village.

There are several different categories of breadfruit names regardless of binomiality or monomiality. For example, one kind of name reflects the appearance of the breadfruit, such as ***'ulu sina*** 'white breadfruit', or ***momolega***, whose name evokes the yolk of an egg in reference to its very yellow flesh. Other names are geographical, reflecting the putative origin of the cultivar such as in ***'ulu manu'a*** 'Manuan breadfruit'. Another kind of breadfruit name reflects culinary properties, as in ***'ulu ma'a*** 'hard breadfruit', which takes a long time to cook. Yet other breadfruit names are comparative in the sense that they reflect overall similarities to another cultivar such as in ***puou maopo***, a '***puou*** that looks like ***maopo***'. Two minor categories are names that are respect terms such as ***maualuga***, which means high, or descriptive actions such as ***'ulu tau*** 'to pluck'. Lastly, eleven breadfruit names, such as ***aveloloa***, are irreducible in the sense that they either cannot be translated or their meaning has been forgotten by contemporary Samoans. The Samoan dictionary (Pratt 1911) defines these simply as "a variety or type of breadfruit."

Recording of Data; Definitions of Idiosyncratic and Expert Respondents.—Using the redacted data set (determined by excluding all idiosyncratic names and all four idiosyncratic interviews) and by combining monomial/binomial variants (using a majority rule) and cognates, a total of 46 different names for breadfruit cultivars were recorded during individual interviews with 350 Samoans. The effect of excluding these four interviews had only a small effect in the mean number of taxa reported (6.3 redacted, 6.4 unredacted) and no effect on the median number reported (6 names), with the number of breadfruit cultivars reported ranging from 0 to 20 names.

Of the 354 individuals who were interviewed, 63 respondents reported 10 or more names, which is one standard deviation above the mean number of names known to all informants. Three of these individuals were excluded as experts because they did not meet the second expert criterion: they did not know 90% of the cultivar names known to more than half of all respondents. Therefore, 60 individuals were defined as "experts." This statistical definition of expertise is compatible with Samoan folk perceptions of expertise. ***Tofa mamao***, which glosses as 'deep understanding', is not found in everyone, but all villagers know who has such 'deep understanding'. In several instances, respondents suggested that we speak with certain villagers because those individuals would know a lot about breadfruit, and this was borne out during in-depth interviews. These individuals had extensive knowledge of other practices concerning breadfruit such as crop

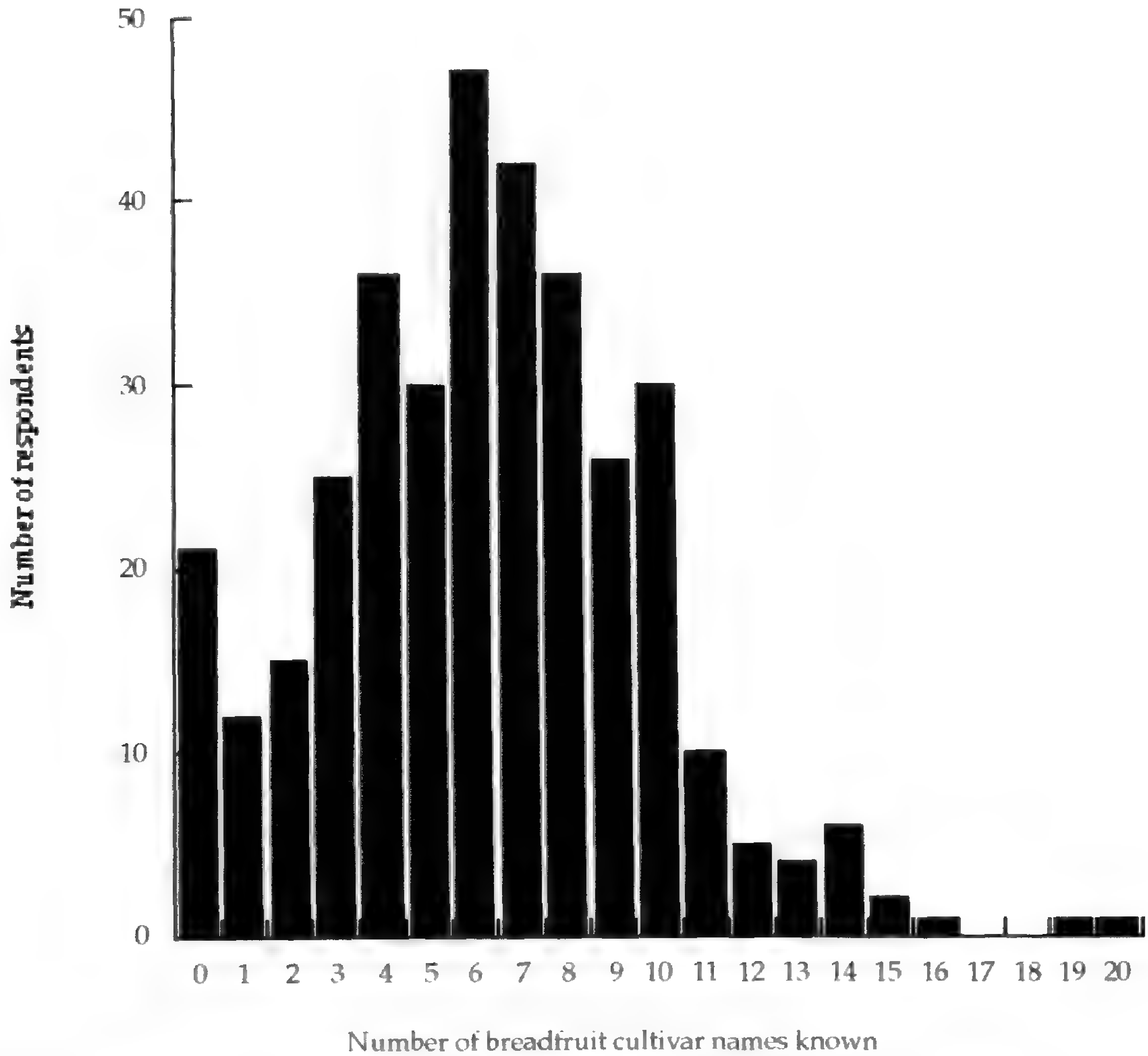

FIGURE 2.—Number of breadfruit cultivar names known by 350 Samoans.

husbandry, how to identify different cultivars, preferred uses, etc. The data are not normally distributed (Figure 2) and do not come from a random sample, so non-parametric statistics were used in the data analysis.

Binomiality, Saliency, and Linguistic Ambiguity.—Using the redacted data set (i.e., the entire data set less idiosyncratic interviews), we sought to study the possible relationship between the saliency of breadfruit names and their binomiality. The cultivar names listed in Table 1 were analyzed for prominence of binomial versus monomial ethnotaxa to see if monomials tended to be more salient.

H_0 = there is no relationship between binomiality and saliency
H_1 = there is a relationship between binomiality and saliency

were tested using a Wilcoxon rank sum test (Remington and Schork 1985; Snedecor and Cochran 1989) and testing at the 0.05 level for significance. Ties were scored by using the average of the ranks of tied numbers. The test statistic ($z = -0.83$) was not significant at the 0.05 level so hypothesis H_1 was rejected: there is no relationship between binomiality and saliency. To limit the influence of infrequent names, the two hypotheses were again tested with the Wilcoxon Rank-Sum using only the 66% most salient taxa. In this second test, H_1 was again rejected ($z = 0.74$). A third test, comparing only the top ten most salient names,

TABLE 3.—Summary of ambiguous and unambiguous binomial and monomial breadfruit cultivar names.

	Binomial	Monomial	Totals
Ambiguous	19 (11.3)	7 (14.7)	26
Unambiguous	1 (8.7)	19 (11.3)	20
Totals	20	26	46

Note: cells have number observed and (expected).

was performed, using a W statistic rather than Z because of the small sample size. In this third test, H_1 was rejected a third time, so we can unequivocally state that there is no significant relationship between saliency and binomiality in breadfruit names reported by 350 Samoans.

The hypotheses

H_0 = there is no relationship between ambiguity and binomiality
H_1 = there is a relationship between ambiguity and binomiality

were tested by constructing a 2 × 2 contingency table, with the columns representing monomial and binomial names and the rows representing linguistically ambiguous and unambiguous names (Table 3). A χ^2 statistic was calculated (χ^2 = 22.2, $p < 0.001$) and tested at the 0.05 level for significance using Yates correction for continuity (Snedecor and Cochran 1989) and H_0 was rejected. Binomiality is significantly related to linguistic ambiguity among our 350 respondents. When Table 1 is analyzed for a relationship between linguistic ambiguity and saliency, the relationship is even stronger: 82% of all breadfruit names are either unambiguous monomials (UM) or ambiguous binomials (AB); e.g., binomials whose specific epithet alone, out of context, could conceivably refer to another object than breadfruit.

These results do not support the rather reasonable assertion by Berlin (1992) that monomials should be used to label highly salient taxa—indeed there is no relationship between saliency and monomiality—but our results do support the indigenous hypothesis that monomials should be used only when the terms are completely unambiguous.

Age, Gender, Westernization and Cultural Competency.—To determine if there was a relationship between age of the respondent and number of breadfruit names reported (Table 4), the median number of taxa reported by respondents in each of nine age classes was calculated (Class 1 = ages 0–9; Class 2 = ages 10–19; etc.). For statistical continuity age cohorts 0–9 and 80–89 were included; they indicate the age decade but do not imply that a 0 age child or an 89 year old adult were interviewed. The three youngest people interviewed were between two and four years old, all others were six years or older. The oldest person was 84 years old. These terms are merely labels for the cohorts. These data were used to test the following hypotheses:

H_0 = there is no relationship between age class and number of breadfruit names reported
H_1 = there is a relationship between age class and number of breadfruit names reported

TABLE 4.—Knowledge of breadfruit cultivar names based on age class.

Age class (years)	Respondents (n =)	Mean	Rank	Difference (D)	D^2*
1 (0–9)	14	1.4	9	−7.6	57.76
2 (10–19)	78	4.1	8	−3.9	15.21
3 (20–29)	78	6.1	7	−0.9	0.81
4 (30–39)	57	6.7	6	0.7	0.49
5 (40–49)	31	7.4	5	2.4	5.76
6 (50–59)	40	8.0	3	5.0	25.00
7 (60–69)	31	9.2	1	8.2	67.24
8 (70–79)	19	8.6	2	6.6	43.56
9 (80–89)	2	7.5	4	3.5	12.25

* Sum of $D^2 = 228.08$; $r = -0.90$.

by calculating a Spearman's rank correlation coefficient and testing for significance at the 0.05 level. Since at 7 ($n - 2$) degrees of freedom, the two-tailed significance level for the correlation coefficient r at the 0.01 probability is 0.798, H_0 is rejected, showing a strong relationship between age class and mean number of breadfruit taxa reported.

We wished to determine if the location of one's residence had any influence on the number of breadfruit names (Table 5) that were known as well as whether gender played a role in such knowledge. Ordinarily an analysis of variance would be used to see if such differences are important. Since these data are not randomly collected independent samples with normal distribution, and since sample variances were not equal for the subsamples, such an ANOVA analysis with the parametric F statistic would be inappropriate. Therefore the nonparametric Kruskal-Wallis test was used which generates a statistic comparable to that of an ANOVA to test using the χ^2 distribution at the 0.05 level of significance for the following hypotheses

H_0 = there is no difference between villages in the number of breadfruit names known

H_1 = villages differ in the number of breadfruit names known.

This test yielded an H statistic of 123.6. Since multiple ties occur in the data set, this statistic was corrected by dividing by the correction factor $(1 - (T^3 - T)/N^3 - N = 0.99)$ where T is the number of ties for each observation and N is the sample size. Our corrected statistic $H_{corr} = 124.7$. At seven degrees of freedom, since H exceeds 203, H_0 at $p < 0.005$ was rejected, hence place of residence is highly significant in influencing number of breadfruit names known.

TABLE 5.—Knowledge of breadfruit cultivar names based on place of residence.

Number of names known	Ofu	Olosega	Afono	Pago	Apia	Falealupo	Saipipi	Expat.
Mean	5.1	5.3	5.5	5	5.6	7.5	8.7	1.6
Median	5	5	6	5	5.5	7	8	2
Maximum	10	11	11	11	11	14	20	4
Respondents (n =)	51	52	28	59	34	33	88	5

TABLE 6.—Knowledge of breadfruit cultivar names based on gender.

Number of names known	All females	All males	Expert females	Expert males
Mean	5.6	7.1	10.9	11.9
Median	6	7	10	11
Maximum	19	20	19	20
Respondents ($n =$)	192	158	23	37

Gender differences were also tested using the Kruskal-Wallis test. The hypotheses were:

H_0 = there is no difference between genders in the number of breadfruit names known

H_1 = men and women differ in the number of breadfruit names known.

For the total of 192 women and 158 men in our sample (Table 6), the corrected H statistic was 21.7, allowing us to reject H_0 at the $p < 0.005$ level: men know significantly more breadfruit names than women.

DISCUSSION

We were impressed by the diversity of breadfruit cultivars recognized by the Samoans in our sample. We are unaware of any major supermarket in the United States that stocks anything approaching this selection of crop diversity, which the Samoans claim grows in and about their villages. Our data set of 350 interviews allows us to do more than to document the richness of Samoan breadfruit diversity; it allows us to test several hypotheses about knowledge of breadfruit.

The five criteria of Brown (1985) are used in determining which Samoan breadfruit names are binomials or monomials: 1) a composite term is considered to be binomial if one constituent of the label stands on its own as the name of the class (e.g., ***'ulu***); 2) one constituent is not a major life-form (e.g., breadfruit 'tree'); 3) morphologically dissimilar (i.e., sea horse is not a type of binomial); 4) shared generic constituent; and 5) composite terms 'mate of', 'like', 'similar' are not binomials. The suggestion that monomials are used in folk taxonomy to label highly salient folk taxa has been asserted for the simple reason that binomial names for lower-salience referents are overall less salient and more easily remembered than monomials (Brown 1985, 1986, 1987). Berlin (1986) argued that it is erroneous to state that the increase in binomial taxa results from an overall decrease in saliency. Rather it is due to direct biological manipulation by humans in the process of domestication and that folk genera with the largest numbers of folk species are always cultivated plants. Folk specific taxa may finely subdivide a single biological species with cultivated plants that have been highly modified under domestication (Berlin 1992). Hays (in Brown 1985) argued that "binomialization might be most common in sets of taxa that are *highly* salient; i.e., domesticated plants or animals of which varieties or species (binomially labeled) would have resulted from domestication." What is needed to test these competing hypotheses has been a direct indicator of saliency in a folk setting.

Frequency of mention in a standard interview as an index of saliency of a folk taxon is adopted here. Using that measure, no support was found for either Brown or Hays: there is no statistical association between saliency and binomiality for names of Samoan breadfruit cultivars. It could be argued that the restricted taxonomic focus (i.e., only breadfruit cultivars are considered) makes our study an inadequate analysis of the broader theory. However, by restricting ourselves to a single crop, "intensity of cultural use" (Turner 1988) is held constant, so our data on comparative saliency are strictly comparable. Studies on other crop cultivars in various places would add considerable power to this basic approach.

Our data also gave partial support for the argument that there is often considerable disagreement among indigenous societies on folk names. Working with the Wola, an agricultural people in New Guinea, Sillitoe (1980) found that they hold in common a set of cultivar names, but when forced to apply these names to actual plants, they only agreed about 50% of the time about which name goes with which plant. He surmised that disagreement over naming plants most likely occurs at this taxonomic level since such identifications frequently depend on fine details of morphological variation (Sillitoe 1995).

Although some slight differences in the use of monomial or full binomial names were noted (as might be expected when attempting to clarify a plant name for a foreign investigator), there was surprising little variation in plant names, once cognates with superficial differences were clumped together in the analysis. What surprised us further was not the differences in names, but the overall consensus in names which were recorded on islands over 400 km apart. The number of idiosyncratic responses, including those we surmise were invented on the spot to please a persistent investigator, was very low. Fewer than one percent of our interviews were excluded from analysis because of idiosyncrasy. In all settings, however, two broadly different realms of ethnobotanical knowledge were found: common knowledge and expert knowledge.

A useful outcome of our study was that we were able to statistically quantify what makes an individual an expert. Future ethnobotanical fieldwork in Samoa will be greatly facilitated by our having defined a large group of experts with whom we can work and conduct in-depth interviews about breadfruit. For example, we will work with some of these experts to ascertain the conservation status of breadfruit cultivars in Samoa, especially those that were only known by one or a few individuals. We surmise that cultivars such as ***ma'afala*** and ***puou***, known by 90% and 81%, respectively, of the Samoans interviewed are common in cultivation and therefore conserved *in situ,* whereas the more uncommon cultivars may be at risk and require special conservation strategies.

A rigorous comparison between folk and statistical measures of expertise is beyond the scope of this paper, but we believe that our statistical definition of expert could benefit investigators conducting ethnobotanical projects elsewhere. It is possible in a fairly short time to interview a large number of people about a specific topic and from that group quickly and accurately identify those who possess expert knowledge about the subject at hand. Working primarily with expert individuals is a useful, and timely, strategy to maximize obtaining reliable, specialized, and verifiable information. In our sample, 17 of the experts were in their 60s and six were over 70 years old. It is critical that the traditional cultural knowledge of these elderly experts, several of whom were in very poor health, be documented before it is lost.

Place of residency has a strong impact on the amount of knowledge about breadfruit names that an individual possesses (Table 5). As might be expected, the traditional villages of Saipipi and Falealupo on the remote island of Savai'i score highest in breadfruit knowledge. We were surprised to find that Ofu and Olosega villages in the remote Manu'a archipelago of American Samoa scored at about the same rate as the residents of the capital cities of Pago Pago and Apia. This may be due to the prevalence of sending high school age boys and girls off-island for education, where they are removed from participating in daily cultural activities and hence do not have the opportunity to learn traditional knowledge and practices from their elders. There is, in effect, a brain drain as adults leave the Manu'a islands for Tutuila, Hawaii, or the U.S. mainland. For example, many families maintain residences both in Ofu or Olosega and on the island of Tutuila. Mid-life adults are working in the wage economy on Tutuila, providing a home for their high-school-attending children, or caring for their elderly parents who have moved to Pago Pago for medical care and long-term convalescence. The mayor of Olosega suggested that since the residents of Ofu and Olosega rely primarily on earned income and family remittances rather than subsistence agriculture, there is little need to keep such breadfruit knowledge alive. In any case, it appears that ethnotaxonomic knowledge is exceedingly fragile, and can quickly disappear, even from apparently remote areas. This is evident by the low rate of knowledge possessed by expatriate Samoans.

Gender differences in breadfruit knowledge can be supposed to reflect the gender-based divisions of labor inherent in Samoan society. Men are more likely to work in the plantations, plant and harvest breadfruit, and prepare them in the ***umu*** or stone ovens. It is important to note that these gender differences, while reflected in the mean and median number of names known by men and women, do not reflect expert knowledge. The second most knowledgeable person about breadfruit names was a woman. In the group of 60 individuals we defined as having expert knowledge, 23 were women and 37 were men. Knowledge about breadfruit among this group of women can primarily be attributed to transmission of knowledge by family traditions. For example, some of these women held ***matai*** titles that are conferred by their families and typically recognize those individuals who are knowledgeable about and practice ***fa'asamoa***—i.e., who maintain traditional Samoan customs and knowledge. Several women were related by marriage and/or birth to ***matai***. If there are no sons living in the household a daughter, out of respect for her father, will become familiar with and learn her family's traditions, including areas of expertise that are normally associated with men. Wives of ***matai*** bring to the marriage their own family traditions and often learn those of their husbands. Upon the death of a ***matai***, wives are the repository of this shared knowledge and ensure that both families' traditions are perpetuated.

In interviews with individuals who work in administration of government and NGO conservation programs in Apia, a modest level of breadfruit knowledge was recorded; certainly above the median (8.5 vs. 6.0 names) for all of our respondents, but below that of the expert level. One individual reported 15 names, placing him well within the expert range, while a long-term expatriate knew only five names. The expert noted that his knowledge was acquired principally from his residence in and subsequent visits to remote villages. This suggests that villagers who possess strong ethnotaxonomic knowledge should be recruited to oversee conservation and agrobiodiversity programs in Samoa and elsewhere. Indigenous knowledge of crop diversity is crucial to guiding conservation and agricultural development projects to ensure that traditional cultivars, cultivation practices, and cultural practices and knowledge are preserved rather than eroded.

NOTES

[1] Herbarium specimens were deposited at PTBG, National Tropical Botanical Garden, Kalaheo, Hawaii.

[2] The standard orthography for Samoan includes a glottal stop or break, indicated here by an apostrophe before the vowel.

[3] Interview with Vaiga Uaealesi, in Saipipi Village, Savai'i, 19 July 2000.

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THE CATEGORY OF 'ANIMAL' IN EASTERN INDONESIA

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ABSTRACT.—It is a generally accepted idea among ethnobiologists that most non-western languages lack a term for 'animal'. Evidence from eastern Indonesia reveals that, understood as labels for an ethnotaxon comparable to vernacular English 'animal', such terms are by no means rare in this part of the Austronesian-speaking world. At the same time, the lexical resources employed to name a general 'animal' category reveal a notable diversity that corresponds to the variety documented by K. Alexander Adelaar in regard to Austronesian languages as a whole. In this article, I review terms translatable as 'animal' in several eastern Indonesian languages. I conclude by addressing issues illuminated by the eastern Indonesian evidence, including the perceptual salience of the 'animal' taxon and Berlin's evolutionary thesis concerning the lexical recognition of categories belonging to different ethnotaxonomic levels.

Key words: Eastern Indonesia, Austronesian languages, ethnotaxonomy, ethnozoological nomenclature, terms for 'animal'.

RESUMEN.—La idea de que la mayoría de las lenguas no occidentales carecen de un término que signifique 'animal' está generalmente aceptada entre los etnobiólogos. Los datos de Indonesia oriental muestran que estos términos, entendidos como etiquetas para un etnotaxon comparable al de 'animal' en español vernáculo, no son en absoluto escasos en esta parte del mundo de habla austronesia. Al mismo tiempo, los recursos léxicos empleados para nombrar una categoría general de 'animal' revelan una notable diversidad que corresponde a la variedad del conjunto lenguas austronésicas. En este artículo reviso los términos traducibles como 'animal' en varias lenguas de Indonesia oriental. Finalizo proponiendo ideas, basadas en la evidencia indonesa, sobre la prominencia perceptual del taxón 'animal' y la tesis evolutiva de Berlin en lo que concierne al reconocimiento léxico de categorías de diferentes niveles taxonómicos.

RÉSUMÉ.—Parmi les ethnobiologistes, il est généralement admis qu'il n'existe pas d'équivalent au terme «animal» dans la plupart des langues non occidentales. Cependant, dans les régions où l'on parle malayo-polynésien, de pareils termes ne sont pas rares et des faits provenant de l'est de l'Indonésie indiquent que ces termes pris en tant qu'étiquettes pour un ethnotaxon comparable au terme anglais vernaculaire «animal» existent. Aussi, de façon parallèle, les ressources lexicales utilisées afin de nommer une catégorie «animal» générale montrent une diversité remarquable qui correspond à celle documentée dans l'ensemble des langues malayo-polynésiennes. Dans cet article, je fournis une synthèse des termes se traduisant par «animal» parmi plusieurs langues de l'est de l'Indonésie. Je termine cette synthèse en soulevant différents points à la lumière des faits tirés de l'est de l'Indonésie, incluant la perception du taxon «animal» ainsi que la thèse évolutive de Bertin qui a trait à la reconnaissance lexicale des catégories appartenant à des niveaux ethnotaxonomiques différents.

INTRODUCTION

In the study of ethnobiological classification, it has become a virtual maxim that terms in nonwestern languages denoting a category corresponding to English 'animal' are uncommon—even "normally" absent (Berlin 1992:15, 27, 190; cf. Berlin et al. 1973:215; Brown 1984:4; Lévi-Strauss 1966:1). Among the Austronesian languages of Indonesia, however, such terms are not nearly so rare as this generalization would suggest. At the same time, as Adelaar (1994:12–13) has noted, Proto-Austronesian, the hypothetical ancestor of all Austronesian languages, appears to have lacked a general term for 'animal'. Accordingly, the lexical means employed by modern Austronesian speakers to refer to 'animal' are remarkably various.[1]

The purpose of this paper is to demonstrate a comparable variety among general terms for 'animal' encountered in several eastern Indonesian languages spoken on the islands of Flores, Sumba, Roti, Timor, and Seram. I further consider the implications of this variety for ethnobiological theory pertaining to folk zoological classification. One interest in this connection is evidence indicating that 'animal' exists, at least as a covert category, even among speakers of languages that lack a term unequivocally denoting the taxon. Especially relevant here is the widespread incidence of numeral coefficients (or classifiers) cognate with Malay *ekor* 'tail' (cf. Proto-Austronesian *'***ikuy** 'tail', Dempwolff 1938:68), which are employed when counting or enumerating any kind of animal (see Berlin et al. 1974: 30; also Taylor 1984:107, 1990:44).

In his review of 'animal' terms, Adelaar (1994:13) lists four general ways in which the folk taxon appears to be labelled in Austronesian languages. These include: naming with a descriptive phrase (or paraphrase) such as 'living creature' or 'animate thing'; with a word denoting a particular animal kind; with a term referring to 'domestic animal'; or with a loan word (often deriving from Malay *binatang,* Sanskrit *sattva,* or Arabic *haywan*). As I demonstrate below, all of these methods are reflected within a much more restricted group of eastern Indonesian languages. This variety is discernible within clusters of the most closely related languages or dialects, and in some instances even possibly within one and the same language.

LANGUAGES OF FLORES, SUMBA, AND TIMOR

All the languages I survey here have been identified by Blust (1980) as members of a Central-Malayo-Polynesian grouping within the Malayo-Polynesian family of Austronesian languages. Included in this grouping are two subgroupings identified by Esser (1938) as the Bima-Sumba and Ambon-Timor groups. More recently, Wurm and Hattori (1981) have proposed a more detailed classification of languages included in the second group, but this need not overly concern us here.[2] Bima-Sumba languages include those spoken on Sumba, Savu, western and central Flores, and Komodo, as well as the Bimanese language of eastern Sumbawa. Of the languages treated in this article, Esser's Ambon-Timor group includes those spoken in more easterly parts of Flores—including Sika, the Lamaholot languages of East Flores (Flores Timur) and the smaller islands immediately to the east (Solor, Adonara, Lembata/Lomblen)—as well as Rotinese, the Tetum (or Tetun) language of Timor, and the Nuaulu language of Seram.

I begin by reviewing Bima-Sumba languages, partly because their ethnozoological lexicons are rather better documented than those of Ambon-Timor languages, and I begin with Nage and closely related dialects of western Keo, since ethnozoologically this is the case that I know best (see Forth 1995, 1999, 2004). An alternative procedure might have been to frame the lexical data with regard to the four methods of labelling 'animal' isolated by Adelaar. However, since some languages exhibit more than one of the four ways of referring to animals in general, this is less convenient.

BIMA-SUMBA LANGUAGES

Nage (and Western Keo), Central Flores.—The Nage term ***ana wa*** labels a category of living things that closely corresponds to the English vernacular sense of 'animal' where it contrasts with 'human'. By the same token, the expression corresponds to modern Indonesian (and Malay) *binatang* 'animal'. Accordingly, Nage recognize the taxon as comprising a number of labelled and unlabelled (or covert) life-form taxa, including ***nipa*** 'snakes', ***ika*** 'fish', and ***ana wa ta'a co*** 'flying creatures' or 'birds' (coinciding mostly with the zoological class Aves), even though the focus of ***ana wa*** is large mammals and then especially domesticated varieties (Forth 1995:47–48).[3] Instancing an apparently universal feature of folk taxonomy, Nage ***ana wa*** definitely excludes human beings (***kita ata***), although, as I discuss presently, the term can be applied metaphorically to a certain category of human beings.

In its most common usage, ***ana*** means 'child, children' or 'child of'. In a broader sense, the term can further refer to a member of any human collectivity or social unity (see, for example, ***ana loka*** 'participant in a ritual assembly or other activity'; ***ana one*** 'insider', cf. ***one*** 'inside'). Since ***wa*** means 'wind,' ***ana wa*** might thus be glossed as 'children, people of the wind'. Entailing a figurative usage (insofar as Nage contrast 'animals' with 'people'), this interpretation is recognized by Nage themselves, who rationalize it with reference to the idea that, like the wind but unlike humans, animals are uncontrolled and unpredictable in their behavior (Forth 1989, 1995:47). Consistent with this representation, Nage further apply ***ana wa*** to small children (***ana éno***; Forth 1995:47–48), who—as one informant explained—do not yet understand speech and cannot be constrained by verbal commands or admonition. (In this connection, the informant noted how toddlers will heedlessly grab at everything in sight.)[4]

Contrariwise, in some contexts Nage use ***ana*** 'child' alone with reference to animals, although mostly it appears with reference to birds. In attempting to identify a particular kind of bird, for example, one might thus inquire ***ana apa ke***? 'what (animal, bird) is that?'.[5] In this context, ***ana*** might simply be construed as an abbreviation of ***ana wa***; alternatively, it can be understood as specifying an instance of a larger collectivity, a 'member of' the larger group of 'flying animals' (***ana wa ta'a co***). Interestingly, in the Wangka dialect of Rembong (northwestern Manggarai), the cognate ***anak*** similarly occurs in ***anak reman*** (***reman*** refers to wild vegetation, see note 16), identified by Verheijen (1977 s.v. ***anak***) as a general term for 'bird'. Also relevant here is the mostly optional use of ***ana*** in Nage names for many kinds of birds (e.g., ***koka*** and ***ana koka***—Helmeted friarbird, *Philemon buceroides*), although ***ana*** also occurs in the names of other sorts of small animals (e.g., ***ana gu***—house lizard, *Hemidactylus frenatus*; ***ana fe***—tadpole; ***ana bo*** and ***ana tebhu***—two kinds of freshwater fish).

Interestingly, a clan resident in villages near the Nage center of Bo'a Wae is named 'Ana Wa'. As shown by their alternative naming simply as 'woe Wa' (clan Wa), however, the name in this context does not necessarily translate as 'animal', but is usually understood to mean 'Wind people'. According to another local interpretation, it can be construed as 'animal', but only in the metaphorical sense of 'small children'.

However ***ana wa*** is precisely to be understood, the Nage term clearly instances the use of a descriptive phrase to express the general sense of 'animal'—or to label an ethnotaxon at the level of the 'kingdom' (or 'unique beginner', Berlin 1992:15). As a general term for 'animal', ***ana wa*** is also known in western Keo, where it was defined as referring to all four-footed animals, livestock, birds, and snakes. Two other Keo terms, both elicited when asking about local terms for 'animal', are ***ngawu nitu*** and ***bugu lara***. Meaning 'possessions (goods, wealth) of spirits', ***ngawu nitu*** more precisely denotes wild animals, and reflects the idea, also found in Nage (Forth 1998:70–72), that various wild creatures are the domestic animals of free spirits (***nitu***). The endemic Flores giant rat (*Papagomys armandvillei*, ***bétu***) is thus considered the water buffalo of these spirits, Green junglefowl (*Gallus varius*) are their chickens, and so on. As these specific equations are restricted in number (if only by virtue of the fact that humans possess limited kinds of domestic animals), it is equivocal how far ***ngawu nitu*** can be understood as including all wild creatures. Nevertheless, in response to questioning, I was assured that ***nipa*** (snakes), for example—which are more often identified as manifestations of ***nitu*** spirits themselves rather than as some particular kind of animal belonging to the spirits—are also included in this category.

The second Keo term, ***bugu lara***, refers specifically to livestock (owned by humans). A synonymous expression recorded in Nage is ***bugu beti***. For the most part equivalent to ***ngawu*** ('wealth, possessions'; also, in context, specifically 'bridewealth'), the relevant sense of ***bugu*** is 'thing, possession, good(s)' (cf. ***bugu ngawu***, wealth, including both livestock and inanimate objects). No one I questioned could explain either ***lara*** or ***beti*** in these contexts. The usual sense of Keo ***lara*** (cf. Nage ***laza***), however, is 'ill, illness', while in neighboring Ngadha, ***beti*** (cf. Nage ***bugu beti***) also means 'ill' (Arndt 1961). One possibility, therefore, is that the phrases distinguish domestic animals from other possessions as things which are subject to illness, and which thus may decrease through sickness and death.

I introduce these expressions in order to demonstrate that, while ***ana wa*** includes both domestic and wild animals in Keo as well as Nage, there are also special terms distinguishing wild and domesticated kinds. Like the general term, moreover, the latter are descriptive phrases designating essentially utilitarian classes of animals as the 'property' of spirits and humans respectively, though a peculiarity of ***ngawu nitu*** is that, by virtue of a cosmological principle of "reciprocal inversion" (Forth 1998), it is used to specify not human livestock but wild creatures.

One interest of the western Keo use of ***ana wa*** relates to the fact that while ***wa*** is the Nage word for 'wind', in western Keo 'wind' is ***waya***. Yet one does not hear ***ana waya***. This circumstance, then, suggests the use of a loan word for 'animal', though one adopted from a neighboring dialect rather than from Malay or another quite different language.

Lio and Endenese, Central Flores.—Located to the east of the Nage, inhabitants of the Lio and Ende regions speak dialects that are closely related to those of Nage, Keo, and Ngadha. Indeed, they form a single grouping with these, distinct from both the language of Sika (spoken immediately to the east of Lio) and Manggarai (the language of western Flores; see Wurm and Hattori 1981:map 40).

In what remains the major source for the Lio lexicon, Arndt's dictionary (1933) lists two terms that may be glossed as 'animal'. One is ***binata***, clearly a loan from Malay (see *binatang*). The same term is given for 'animal' in Endenese (Stokhof 1983; Suchtelen 1921:330, for the 'Ja'o' dialect). For Lio, Arndt defines ***binata*** more specifically as 'large animal, especially four-legged animals'. However, according to Takashi Sugishima,[6] an anthropologist who has recently conducted extensive research among Lio, the term is further employed in the general sense. (Sugishima also states that ***binata*** is often used in contradistinction to a term for 'human being'—for example when abusing people by comparing them with animals.) Although the Lio term is obviously borrowed from Malay *binatang*, for it to appear in a dictionary published as early as 1933—and in regard to Suchtelen's Endenese word lists, in a publication dated 1921—it must have been adopted in this part of Flores before the earliest years of the twentieth century. In fact, the adoption likely occurred prior to the era of effective colonial administration, a circumstance entailing that its introduction in Lio and Endenese was not a function of widespread bilingualism or the establishment by the Church of elementary education in Malay.

Another possible candidate for 'animal' in Lio is ***ule*** (Arndt 1933). As in Nage and other Flores languages, the primary meaning of Lio ***ule*** is 'worm, maggot, grub' (see Appendix 1). The term is thus comparable to Malay/Bahasa Indonesia *ulat* 'caterpillar, worm, insect', and, like the latter, evidently reflects a Proto-Austronesian or Proto-Malayo-Polynesian form that referred, at least primarily, to worms and similar creatures.[7] In regard to the variety of small creatures named by the term, ***ule*** (like Malay *ulat*) appears largely to correspond to the sort of widespread folk taxon generally designated 'wug' (a neologism formed from 'worm' and 'bug'; see Brown 1984:16). Yet ***ule*** further occurs in compound names of several Lio folk generics that denote birds.[8] Among these are ***ule a*** 'crow', ***ule mesi*** 'heron', Stokhof 1983, ***ule mi'u*** 'a bird that shrieks ***mi'u***', ***ule si*** 'a small bird', ***ule molo***, and ***ule polo***.[9] A particular connection of Lio ***ule*** with birds is further indicated by the term ***haba ule*** 'bird's nest' (Arndt 1933:132, s.v. ***haba*** '(bird's) nest', cf. ***haba manu*** 'hen's nest').

Other Lio compounds with ***ule*** listed by Arndt (1933) denote folk generics including worms, grubs, and insects. In regard to the application of the term to birds, it is interesting that of five insect terms, at least four refer to flying insects (see ***ule ae*** 'various sorts of dragonflies', ***ae*** 'water'; ***ule api*** 'wasp with a red lower body', ***api*** 'fire'; ***ule hetu*** 'moth'; ***ule n'gake*** 'butterfly'; ***ule si*** 'a sort of beetle, chafer' but also a small bird). Apparently nonzoological applications of Lio ***ule*** include ***ule re'e*** (***re'e*** 'bad, mean, ugly'; cf. Nage ***'e'e***) and ***ule ola***, both of which Arndt translates as 'evil spirit' (German *böser Geist*). The first term, however, Arndt additionally glosses as 'all poisonous snakes' (see note 3, regarding Nage ***ana wa ta'a 'e'e***).

It therefore appears that in Lio, a term originally denoting worms and similar small creatures has become extended so as to encompass a far more inclusive category of living things. In other words, one is evidently dealing with an instance of a word denoting a particular animal kind being applied, if not to animals in general, then to a significantly wider variety of creatures than those originally labelled by the term. Interestingly, a remarkably similar extension appears to have occurred in the Tetum language of Timor, as indicated by Hull's (2001) gloss of ***ular*** as both 'worm, caterpillar; crawling insect' and 'creature, animal'. Further evidence for the Lio term is provided by Arndt (1933), who translates ***ule*** as 'creature, worm, grub (larva), maggot, bird' (German: *Getier, Wurm, Larve, Made, Vogel*). Arndt also lists the compound ***ule age*** as 'all kinds of animals, worms, reptiles, and birds' (*Getier, Würmer, Reptilen, Vögel*). On the other hand, according to more recent evidence provided by Sugishima (see note 6), ***ule age*** refers exclusively to birds, serving as "a general term for birds, except chickens."

In view of the meaning of ***ule*** (and cognates) in other languages, it may be significant that, in addition to birds, the majority of Lio compounds in which ***ule*** occurs severally denote small creatures (dragonflies, wasps, larvae, moths, caterpillars, butterflies, worms). According to Sugishima (see note 6), Lio do not apply ***ule*** to mammals or fish, although they do refer to some poisonous snakes as ***ule bani*** (***bani*** 'angry', 'aggressive, bold'). Also noteworthy in this connection is the fact that German *Getier,* Arndt's first gloss of ***ule***, not only has the collective sense of 'creatures', but also applies especially to insects (see Tyrell et al., s.v. *Getier*). There is thus a suggestion that Lio ***ule*** refers only to certain kinds of animals, mostly smaller ones, so that the term may accurately be glossed as 'animal' (or 'bird', 'snake', and so on) only in the context of compound expressions, where the word is modified by another, or in expressions referring collectively to a variety of creatures, where the inclusion of particular kinds is ambiguous.

Insofar as ***ule*** can refer to snakes, it should be noted that the Lio term cannot be interpreted as a retention of Proto-Austronesian ****ulaR*** (or ****qulej***) 'snake, worm' (Zorc 1994:593, 550). Not only had 'snake' become separated at the Proto-Malayo-Polynesian level, as ****nipay*** (Zorc 1994:550), and perhaps earlier (in Proto-Hesperonesian-Formosan = Western Austronesian and Formosan, Zorc 1994:550) as ****buLay***, but the evidence of other Flores languages reveals cognates restricted to worms, maggots, and other similar small animals. It would appear, therefore, that the Lio usage represents a special development, not simply a reversion to a more generalized meaning but a shift to one evidently more inclusive than that of the Proto-Austronesian form.

Obviously, the suggestion that ***ule*** serves as a general term for 'animal', like Nage ***ana wa***, requires considerable qualification. Nevertheless, it is clear that, in Lio, the term has acquired an ethnozoological sense that is far more inclusive than 'worm, maggot', and which moreover subsumes creatures belonging to more than one life-form—notably, birds and snakes. Yet, by the same token, one cannot definitely conclude that ***ule*** unequivocally denotes an ethnotaxon encompassing all zoological life-form taxa, or figures as a component of productive expressions (such as Nage ***ana wa ta'a co*** 'flying animals' or 'birds'). The Lio compound ***ule age*** does not necessarily contradict this characterization. Since ***age*** appears to have no separate meaning, it cannot decisively be interpreted as a modifier specifying a particular segment of animal kinds. Nor does it clearly function adjectivally, in this context or in any other. On the other hand, another Lio term generally denoting wild birds, ***ule bene*** (see note 6), can be analyzed as 'wild ***ule***' (see ***bene*** 'grass, weeds, bush', Arndt 1933; also note 16). Hence in this instance at least, ***ule*** does appear to approximate the general sense of 'creature', even if the term cannot be used alone to mean 'animal'.

While in the absence of further evidence regarding Lio usage one cannot definitely conclude that ***ule*** designates an 'animal' taxon, a fascinating comparison may be found in Chinese *chong* (or *chung*). Like ***ule***, the commonest gloss of *chong* is worm, but other senses of the word include 'insect', 'caterpillar', 'larva', and 'vermin' (*A Pocket Chinese-English Dictionary* 1978). In addition, various kinds of evidence indicate that, in the past, *chong* has functioned as a general term for 'animal'. According to the etymologist Xu Hao, in sixteenth-century China *chong* was used for 'animal' regardless of the method of locomotion or physical form of the creature referred to (*Chinese Etymological Dictionary* 1981). Accordingly, *chong* further occurs in the names of a variety of particular animal kinds, including 'tiger' (*da-chong*, literally 'big worm') and 'snake' (*chang chong* 'long worm'). At present, however, all of these categories possess alternative names. Also, in modern Chinese, the general term for 'animal' is *dong wu*.[10]

If there is an explanation for this similarity between Chinese and Lio, it might be found in a widespread, and probably universal, conception of animals as things that move (or are animated). Thus, as the smallest and morphologically simplest of moving things, and perhaps as creatures which, for humans, display a particularly salient kind of movement (wriggling or crawling), worms, or perhaps better said 'wugs', might be regarded as something like 'atoms' of animation.[11] Also worth noting in this connection is ***makayidi-yàdaku***, the eastern Sumbanese term for 'animal', which, as I describe more fully below, includes the component ***yàda*** 'to team, swarm, wriggle, fidget'.

Eastern Sumbanese.—As recently discussed in another article (Forth 2000), eastern Sumbanese possesses at least one expression that functions as a general name for 'animal'. This is ***makayidi-yàdaku*** 'things that move', a sense that reveals another instance of the use of a descriptive phrase to label 'animal'. The basis of the expression is the compound ***yidi-yàda***, comprising two roughly synonymous terms meaning 'to move', and producing an alliterative sound symbolism comparable to English 'topsy-turvy' or 'twist and turn'.[12] Both Onvlee (1984) and Kapita (1982, s.v. ***kayidiku***) further gloss the expression as 'the whole of creation' or 'all creatures'. (Like Nage ***ana wa***, however, the category definitely excludes human beings.) As these glosses might suggest, ***makayidi-yàdaku*** is used mostly when speaking of 'animals' in general, rather than referring to single individuals or single kinds. Nevertheless, not only is the term regularly applied to a variety of animals, but it is recognized by Sumbanese speakers as denoting a category that subsumes less inclusive categories, particularly ***mahawurungu*** 'flying things' (mostly birds) and ***mabei*** 'creeping, crawling things', a large and internally diverse category that includes insects, arachnids, reptiles, amphibians, and even fish.

Although ***makayidi-yàdaku*** can denote all nonhuman animals, its focus appears to be undomesticated kinds. Consistent with this, ***yàda*** can mean 'wild, untamed, difficult to tame', as well as 'to move, be capable of movement' (Kapita 1982; Onvlee 1984). According to Onvlee, ***yàda*** refers more specifically to a quick movement; thus he further translates the word as 'to teem, swarm' and 'to wriggle, fidget'. Somewhat curiously (since one might expect the contrast to be with ***yàda***), he also describes ***yidiku*** as denoting a movement slower than ***yidi***.

Similar to Nage and Keo, eastern Sumbanese possesses a special term for domestic animals. This is ***banda***, the main sense of which is 'goods, possessions, wealth' (cf. Bahasa Indonesia *benda;* also Nage and Keo ***bugu, ngawu***). As this derivation may suggest, the term refers particularly to large livestock, a mainstay of the Sumbanese traditional economy. Informants in the eastern Sumbanese domain of Rindi stated that ***banda*** could be understood in the wider sense of 'animal' (Bahasa Indonesia *binatang*), and that wild animals could then be distinguished as ***banda matàmba*** 'wild ***banda***'. Yet neither Kapita (1982) nor Onvlee (1984), the principal lexicographers of Sumbanese languages, records the latter phrase, and I suspect that, even at present, it is not a widespread or standard usage. Whatever the extent of their semantic overlap, ***makayidi-yàdaku*** and ***banda*** are not obviously related by taxonomic inclusion. By the same token, ***banda*** suggests a utilitarian category, referring mostly, if not entirely, to a class of economic values.

Mostly in the sense of 'wealth', variants of ***banda*** appear in other eastern Indonesian languages. A case where the more inclusive meaning has become restricted, not just to 'domestic animal, livestock', but to a particular domesticate, is Nage, where the cognate ***bhada*** is the name of the water buffalo, the most valuable animal in Nage traditional economy.

Manggarai, Western Flores.—As a general term for 'animal', Manggarai ***kaka*** in some ways presents a more complex case than any of the usages reviewed above. To a greater extent than Lio ***ule***, the lexeme appears in a large variety of Manggarai bird names (e.g., ***kaka ketok***, Sunda pygmy woodpecker), all of which apparently label folk generics (see Appendix 2). It also occurs in generic names for other kinds of animals, mostly snakes and insects (e.g., ***kaka ta'a***, Green tree viper, *Trimeresurus albolabris*), as well as in the life-form terms for 'bird' and 'snake', ***kaka lélap*** (***lélap*** 'to fly') and ***kaka léwe*** (***léwe*** 'long').[13] For purposes of internal comparison, it should be noted that, in place of ***kaka***, several Manggarai animal terms comparably incorporate ***kala*** (see ***kala mango***, a kind of crab; ***kala wara***, a kind of small red ant; and ***kala wura*** 'watercock'; Verheijen 1963:686; 1967). According to Verheijen, ***kala*** derives from ***kaka*** by dissimilation (1963:685 n. 68).[14] Whether this also applies to ***kara***, a component of the names of just two birds (***kara kuak*** and ***kara kua wié***, the White-breasted waterhen and the Night heron) is not indicated.[15]

In all of these usages, ***kaka*** and variant forms resemble Lio ***ule*** insofar as the resultant compounds apply primarily to insects, birds, and snakes. Yet ***kaka*** differs from ***ule*** (mostly in the sense of 'maggot, worm') in that, by itself, it appears not to designate simultaneously any folk generic, intermediate, or life-form taxon. This circumstance lends support to Verheijen's (1963, 1967) interpretation of ***kaka*** as a general term for 'animal'; hence an expression like ***kaka léwe*** 'snake' might be straightforwardly translated as 'long animal,' and ***kaka lélap*** 'bird' as 'flying animal.' To illustrate the general sense of animal, Verheijen further cites the phrase ***tjala oné kaka*** (1967 s.v. ***kaka*** I) 'perhaps some animal has entered'. This, he notes, can refer, for example, to a wild pig that may have invaded a cultivated field or an ant that has crawled into a placenta (kept after the birth of a child)—usages which affirm that ***kaka*** can refer to quite various zoological kinds.[16] Other usages with the same import include ***akit le kaka*** '(to be) bitten by an animal' (Verheijen 1967, s.v. ***soro*** II) and ***ngo bang kaka*** 'to go hunting', which incorporates ***ngo*** 'to go' and ***bang*** 'to bring', and more specifically means 'to bring dogs in order to hunt' (ibid. 1967:186, s.v. ***kaka***; see also ***bang motang*** 'to hunt wild pigs', ***motang*** 'wild pig', ibid.: 29, 337).

The character of the Manggarai term, however, is complicated by the appearance of ***kaka*** in Nage and Ngadha names for quite diverse natural kinds, including, in a couple of instances, plants. In these languages, ***kaka*** occurs as a reference to living things only in a limited number of binary names for what are apparently folk generic categories. Nage contains six such names. While similarly few in number, the Ngadha compounds refer partly to creatures different from those designated by the Nage terms. Further variety is revealed by ethnozoological categories named with ***kaka*** which Verheijen records for Komodo, a language closely related to Manggarai (see Appendix 2).

Some explanation for this diversity is available from evidence suggesting that, in at least some of the Nage terms, ***kaka*** reflects homonymous usages. For example, ***kaka*** in the Nage name of the Dollarbird is locally construed as an onomatopoeic imitation of the bird's harsh cry, whereas in ***kaka kea***, the more elaborate name of the Yellow-crested cockatoo (also simply called ***kea***), ***kaka*** may be understood as a cognate of words with the same or similar referent in other Malayo-Polynesian languages (see Ngadha and Manggarai ***kéka***, eastern Sumbanese ***kaka***, Malay/Bahasa Indonesia ***kakatua*** 'cockatoo'; Proto-Polynesian ****ka(a)kaa*** or ****kakaa*** 'parrot species', Wurm and Wilson 1975:147). By further contrast, ***kaka watu***, the Nage name for a fish that characteristically inhabits the rocky bottoms of bodies of water, can be interpreted as incorporating ***kaka*** in the sense of 'to stick, adhere, be attached to' and ***watu*** 'stone, rock'. (It is conceivable that ***kaka*** also has this meaning in the name of the Praying mantis, ***kaka koda***.) The sense of 'to adhere, be attached to', which applies in Ngadha as well as Nage, would also explain the occurrence of ***kaka*** in Florenese names for life-forms other than animals. Thus, the two Ngadha terms, ***kaka bheto*** and ***kaka kaju***, denoting an unidentified edible plant and species of *Ficus*, ferns, or vines (Verheijen 1990: 26), can be translated respectively as 'what attaches to ***bheto*** bamboo' and 'what clings to trees'.[17]

This evidence tends to rule out the possibility of Nage and Ngadha compounds representing remnants of an earlier classification in which ***kaka*** consistently denoted a far more inclusive category of living things, and ultimately an 'animal' taxon as, according to Verheijen, it does at present in Manggarai. It is similarly difficult to see how ***kaka***, either in Manggarai or central Flores languages, could represent a semantic expansion of a term that formerly possessed a more restricted range of reference (as, hypothetically, Lio ***ule*** once did). For the Manggarai usage, a more likely interpretation can be found in further glosses of ***kaka*** listed by Verheijen (1967). These include 'thing, object, article' and nominalizing functions of ***kaka***, in particles translatable as 'that which', 'the thing which', 'one who' (cf. Bahasa Indonesia *yang*). Rather than 'flying animal', therefore, the Manggarai term for 'bird' (***kaka lélap***) might be glossed as 'that which flies' (cf. eastern Sumbanese ***mahawurungu***, where ***ma*** is the nominalizer) or 'flying thing'. Similarly, ***kaka langu***, the one nonzoological Manggarai name incorporating ***kaka***, which denotes a toxic mushroom (Verheijen 1967:186 s.v. ***kaka***), can be translated as 'that which intoxicates' (see ***langu*** 'to intoxicate', 'to act as though drunk'). Further supporting this interpretation, the large majority of Manggarai ***kaka*** compounds referring to living things do indeed translate as 'that which (has a certain appearance)' or 'the one that (behaves in a certain way, makes a certain sound)' (see Appendix 2).[18] The point applies equally to compounds with ***kala***. Thus ***kala wura*** (watercock), for example, may be interpreted as 'one which is ***wura*** (a dead spirit)'; in fact, Verheijen provisionally glosses the name as 'animal of the spirits of the dead' (1963:868, n. 87).[19]

In view of Verheijen's knowledge of the Manggarai language and of Manggarai culture and natural history, one can hardly doubt his interpretation of ***kaka*** as a general term for 'animal'. Nevertheless, the usage is likely to have developed as a synecdoche, whereby a word meaning 'thing, entity' has come to denote something more specific, namely, 'living, animate thing'. Yet there remains the question of which, if any, of Adelaar's four methods of designating 'animal' Manggarai ***kaka*** exemplifies. If my interpretation is correct, ***kaka*** 'thing' may have its ultimate source in a hypothetical compound, *****kaka X*** 'thing that X', where X was a word designating movement or the quality of animate life. Thus we may ultimately be dealing with a descriptive phrase comparable to eastern Sumbanese ***makayidi-yàdaku*** 'things that move'. Yet it is also possible that ***kaka*** 'animal' simply represents a generalization from the variety of compounds referring to particular animal kinds in which the term occurs—that is, as a kind of fictive etymology. Although Verheijen (1967) gives 'livestock' as one gloss of ***kaka***, there is no reason to believe that this is the primary meaning, or that this meaning is the derivation of the more general sense of 'animal'.

AMBON-TIMOR LANGUAGES

Rotinese.—The Rotinese term for 'animal', ***bana*** (dialectal ***banda***, Jonker 1908), provides an instance of a term denoting domestic animal having come to be used in the more general sense. Although ***bana*** is obviously cognate with Bahasa Indonesia/Malay *benda* (see previously) and eastern Sumbanese ***banda***, it is unclear whether the term retains 'domestic animal' as its primary sense. Jonker glosses the word first as 'animal, especially a four-footed animal', and lists ***bana fuik*** and ***bana aek*** as compounds specifying 'wild animal' and 'tame, domestic animal' respectively. At the same time, he translates ***bana manu*** as 'all sorts of animals, four-footed animals and birds, livestock and poultry'. Insofar as Rotinese ***manu*** refers specifically to the domestic fowl, this might suggest that the phrase applies, if not exclusively, then in the first instance to domestic kinds. It also suggests a distinction between 'animal' and 'bird' comparable to one sense of English 'animal'.

Tetum (Tetun), Timor.—Closely related to Rotinese, and also classified by Wurm and Hattori (1981) as a member of a Timor and Islands subgroup within a larger Timor Area group (see note 2), the Tetum language of Timor contains at least two words for 'animal'. One is ***binatan*** (Morris 1984), obviously borrowed from Malay (i.e., *binatang*); the other is ***balada*** 'animal, beast' (Hull 2001; cf. ***balada si'ak*** 'wild beast'), which is not explained. In addition to these, another, possibly older way of referring to animals in general is the expression ***buat na'in***, glossed by Morris (1984) as 'living things, any unspecified animal'. Tetum ***buat*** means 'thing, object' (cf. Manggarai ***kaka***). ***Na'in*** functions as a title of respect and a numeral coefficient for persons, and is further described as referring to things that possess agency, or some particular power or skill; thus ***liras na'in***, for example, means 'things that have the capacity to fly' (Morris 1984:146–147). Also noteworthy in this connection is the form ***na'i*** 'lord, master' (Hull 2001). Evidently an instance of the honorific use of the term, ***na'i*** occurs in the compounds ***na'i-bei*** 'grandfather, ancestor; crocodile', and ***na'i-boku*** 'species of large kite'.

Tetum ***buat na'in*** provides a further example of the use of a descriptive phrase to designate 'animal'. The essential qualification is evidently provided by ***na'in***, alluding to agency and the possession of (a specific) physical power. Semantically, therefore, the expression is most comparable to Sumbanese ***makayidi-yàdaku*** 'things that move'.

Nuaulu, Seram.—Although included in Esser's Ambon-Timor group, the Nuaulu language, spoken on the Moluccan island of Seram, is a fairly distant relative of Tetum and Rotinese. Wurm and Hattori (1981) place it in a Central Maluku group, separate from the languages of eastern Flores and Timor. Nevertheless, thanks to the work of Roy Ellen, Nuaulu is one of the few eastern Indonesian languages for which we possess detailed evidence with respect to ethnozoological classification, and for this reason alone it is worthy of comparative consideration.

According to Ellen (1993a:96), Nuaulu ***ipai*** serves as a general term for 'animal', but does not clearly include all life-forms that one might expect to find under this rubric. This equivocality appears largely to reflect disagreement or indifference among Nuaulu themselves. At the same time, ***ipai*** can be used in exclusive contrast to 'human' (***mansia***), in which context, Ellen (1993a:97) states, "it appears to be used to refer to all non-human animals." Otherwise, the term may have as its primary sense "terrestrial animals, contrasted with those of sea and air" (Ellen 1993a:96). Consistent with the first specification, Ellen also describes the Nuaulu term as somewhat resembling the polysemous use of 'animal' in English. He does not state whether or not Nuaulu explicitly consider named life-form categories (such as 'bird', ***manue***, or 'snakes and allied forms', ***tekene***) to be included within ***ipai***, nor does he discuss the possible derivation of the term. Nevertheless, the ethnographer's statements on the whole suggest that ***ipai*** functions as a label for a general category of 'animal' to about the same extent as does Nage ***ana wa*** or Manggarai ***kaka***.[20]

CONCLUSIONS: LEXICAL VARIETY AND SEMANTIC UNIFORMITY

As the foregoing discussion has demonstrated, general terms for 'animal' found in eastern Indonesian languages exemplify all of the four ways of denoting this taxon identified by Adelaar. Naming with a descriptive phrase is illustrated by the Nage, Sumbanese, and Tetum usages. The use of a term referring to a more exclusive animal taxon is exemplified by Lio ***ule***. A term that originally referred to domestic animals is represented by Rotinese ***bana*** (and, in a qualified sense, by Sumbanese ***banda***). Finally, the use of loan words (in all instances from Malay *binatang*) is instanced by Lio ***binata*** and Tetum ***binatan***, and also in Nuaulu (see note 20, regarding ***binatan***).[21] As this distribution illustrates, one method is not confined to the Bima-Sumba group of languages, nor to the Ambon-Timor group. In fact, as the Lio, Sumbanese, Tetum, and Nuaulu usages suggest, speakers of a single language may use more than one kind of term to express the general idea of 'animal'.[22]

With the possible exception of Manggarai and Nuaulu, none of the languages discussed above includes a single unanalyzable lexeme serving as a general term for 'animal', as exemplified by Malay *binatang*.[23] In this respect, the usages contrast with terms for particular life-forms, such as Nage ***nipa*** 'snake'. Yet this does not mean that eastern Indonesians, or a significant portion of them, lack a well-defined concept of 'animal'. As noted earlier, that they do possess such a concept is demonstrated by the widespread Austronesian grammatical feature of employing a single numeral coefficient when enumerating animals belonging to diverse life-forms (cf. Berlin et al. 1974:40, who describe the obligatory use of numeral classifiers in Tzeltal as distinguishing "unambiguously bounded" unique beginner taxa comprising 'plants' and 'animals'). All utilizing the word for 'tail' (see also Malay *ekor*), instances drawn from languages surveyed in this article include Manggarai ***iko***; eastern Sumbanese ***ngiu***, from ***kiku*** 'tail'; and Nage, Keo, and Lio ***éko*** (see e.g., Nage ***ja éko telu*** 'three horses', ***nipa éko wutu*** 'four snakes', ***hale éko lima*** 'five flies'). A comprehensive 'animal' category is also implicit in such representations as the Nage taboo on speaking to animals, a prohibition whose consequential breach is described in oral tradition as involving such diverse creatures as snakes, crayfish, and goats (Forth 1989, 1998). In addition, as I hope to show in a future paper, the Nage category of 'animal' is indicated by the use of sex terms—comparable, for example, to English 'bull' and 'cow' and 'buck' and 'doe'—which among living things are assigned only to zoological folk generics and not to plants (see Taylor 1990:117, who describes how, among the non-Austronesian speaking Tobelo, plants as well have both male and female forms, even though in the majority of cases Tobelo are unable to identify these). Among Nage, sex terms are assigned to all categories of animals (***ana wa***), including reptiles, amphibians, fish, and insects as well as mammals and birds, and all are thought to engage in sexual intercourse, a behavior which Nage are not in every case able to verify empirically.

Yet even if one accepts that all eastern Indonesians possess a category of 'animal', it may not always be clear how far particular terms—whether analyzable or not—actually name the concept. As shown, usages that are equivocal in this regard include Lio ***ule*** and, probably, Nuaulu ***ipai***. What the evidence does show, however, is that these, like the other eastern Indonesian terms described above, denote folk taxa which include two or more life-forms (such as 'bird', 'snake', or 'fish'). That they do not definitely subsume all life-forms that a modern English speaker might wish to classify as 'animals' is a dubious criterion for rejection. Moreover, it is arguably typical of all folk categories, pertaining to so inclusive a taxonomic level, including of course English vernacular 'animal', that they are inherently indefinite and subject to "prototype effects" (Lakoff 1987), and that what speakers and culture participants will recognize as included will be situational, marked by ambivalence, and subject to individual variation.[24]

All of the foregoing bears upon Berlin's well-known thesis concerning the evolution of ethnobiological classifications (1992). According to Berlin, in the development of a language, (folk) generic taxa (local categories mostly coinciding with scientific species or genera) will be named, or "lexically recognized," before higher order taxa, that is, life-form categories (such as 'snake', 'bird', 'fish', and so on) and 'intermediate' classes (categories comprising a limited number of similar generics included in a life-form, e.g., 'birds of prey'). Later still, according to this theory, names will be assigned to 'subgeneric taxa' (ones comprising 'folk species' and 'varietals'), while lexical recognition is finally given to the 'kingdom', of which 'animal' and 'plant' are of course the prime examples (Berlin 1992:274–75). How many of these taxonomic levels are distinguished by name, in Berlin's view, reflects the level of technological development of the society in question.

In spite of ambiguity surrounding the question of what constitutes a 'name', the evidence of eastern Indonesian languages appears generally to support Berlin's thesis. It almost goes without saying that the large majority of standard names for animals in these languages denote folk generics. In addition, usually two or more life-forms are labelled, and such labels often reflect reconstructed forms at the level of Proto-Austronesian or Proto-Malayo-Polynesian (see, for example, Nage, Ngadha, Lio, Endenese ***nipa*** 'snake'; central Flores ***ika***, Sikanese ***i'ang***, eastern Sumbanese ***iyangu*** 'fish'; and Tetum ***manu***, Nuaulu ***manue***, and Rotinese ***manupui*** 'bird'). On the other hand, the degree to which eastern Indonesians label 'intermediate categories' is difficult to determine and defies any succinct summary—a situation which appears largely to follow from an inherent ambiguity reflected in the very designation 'intermediate'. But even if life-form taxa (and perhaps some intermediates as well) are more consistently named than is the 'animal' taxon, this does not mean that early Austronesians (speakers of ancestral languages corresponding to Proto-Malayo-Polynesian or Proto-Austronesian) did not have ways of denoting 'animal (in general)'. Indeed, the fact that the several eastern Indonesian languages surveyed here reveal precisely the same limited number of nomenclatural methods as do Austronesian languages in general tends to suggest that they did.[25] In other words, these various ways of naming 'animal' may have developed no later (to retain the diachronic idiom) than did those for these other 'higher order', or supergeneric, taxa. Although the point cannot be fully developed here (but see Forth 1995, 2000, 2004), it may also be noted that names for several life-forms—e.g., Nage ***ana wa ta'a co*** and eastern

Sumbanese ***mahawurungu*** 'bird' (see also Sikanese ***kenaha horong*** 'flying thing', Pareira and Lewis 1998)—consist of descriptive phrases and so are formally identical to terms for 'animal' in the same languages. The same may apply to Manggarai terms for 'bird' and 'snake', if as hypothetically suggested, ***kaka*** 'animal', derives from a similar compound translatable as 'living thing'.

Two further points should be made regarding Berlin's evolutionary theory. First, if the driving force is technological development, then differences in lexical recognition of different taxonomic levels are evidently a matter of culture rather than human cognition per se. Secondly, if ethnobiological classification is seen to be grounded in universal factors of perception (which is Berlin's position, and one that I basically accept), then it is not clear how it can be subject to any sort of cultural evolution. Only in this light may one usefully raise the question of the 'naturalness' or perceptual salience of the taxon 'animal'. It is by now well accepted that 'generic' categories—also called 'basic' categories, and in psychology and logic, 'basic-level' kinds or 'individuals', and 'basic level sortals'—are those which present themselves in perception as the most obviously discrete, and hence lend themselves most readily to lexical differentiation. By the same token, it is the representation of these categories that appears to be the most independent of the practices and values of particular cultures. Yet it should be considered that a category like 'animal' possesses almost equal salience, especially in regard to the property of movement (or animation), which as it were naturally distinguishes animals of all kinds as objects unlike all other objects, including ones that may be recognized as equally possessing the property of life (most notably, plants).[26] By contrast, intermediate categories (for example, groupings of birds encompassing several similar folk generic categories), and even some life-form taxa (for example, smaller creatures sometimes subsumed in named 'wug' categories), are arguably less psychologically salient, which is to say that their recognition, lexical or otherwise, may be as much dependent on particular cultural interests. Of course, one may ask why, if 'animal' possesses such salience, are names for this category apparently so uncommon? One response might be, again, that recognition of a taxon does not always result in monolexemic naming. However, if 'name' is understood in an inclusive sense, with reference to the evidence of eastern Indonesian languages I would also suggest that such names may not in fact be as uncommon as has hitherto been supposed.

NOTES

[1] Adelaar bases this assessment on data from 80 languages, belonging to four main branches of the Austronesian family, which are recorded by Tryon (1994).

[2] Wurm and Hattori (1981) retain Esser's Bima-Sumba group (noting its ultimate derivation from the work of J.C.G. Jonker), but place the Ambon-Timor languages of eastern Flores and the islands of Solor, Adonara, and Lembata in a 'Flores-Lembata subgroup', which they then classify within a 'Timor Area group'. Ambonese and other Moluccan languages are then placed in a 'Central Muluku group'.

[3] Formally comparable to ***ana wa ta'a co*** is ***ana wa ta'a laka*** 'crawling, creeping animals', a term I first encountered in the Keo region. The category, however, encompasses snakes

(***nipa***) as well as a wide variety of other fauna, including insects, worms, grubs, crustaceans, amphibians, large reptiles like monitor lizards and marine crocodiles, and even rats and mice (***dhéke***). Subsuming or cross-cutting two and possibly three named or unnamed life-form taxa, it is difficult to see how the category could itself constitute a taxon. As Nage informants pointed out, moreover, the term can situationally include creatures that normally fly (***co***) or swim (***nangu***), such as eels and crayfish when they find themselves on dry land, and flying insects like locusts and butterflies which otherwise creep or crawl; human infants also crawl. Consistent with this, ***ana wa ta'a laka*** appears not to be regularly employed as a standard category, in which respect informants contrasted it with ***ana wa ta'a co***. With regard to the application of the latter term specifically to birds (including bats), and not to flying insects, it is noteworthy as well that all insects that fly (***co***) also creep or crawl (***laka***). A similar category, also initially recorded in Keo and apparently less familiar to Nage, is ***ana wa ta'a 'e'e*** 'ugly, disgusting animals', which is identified with snakes—or more particularly dangerous snakes (such as the Russell's viper, ***nipa ba***), and certain kinds of grubs.

[4] For Térong-Mawong, one dialect of Rembong, a language of northeastern Manggarai, Verheijen similarly records the cognate ***anak wara*** (***wara*** = Nage ***wa*** 'wind') in the sense of 'baby, infant'. In Rembong, the expression does not simultaneously serve as a general term for 'animal', although, interestingly enough, in another Rembong dialect (Wangka), ***anak wera*** is listed as a euphemism for 'wild pig'. ***Wera*** 'spirit, spiritual being' is cognate with Ngadha ***wera*** and Nage ***wa***—thus apparently a homonym of Nage ***wa*** 'wind'—both of which refer to the malevolent spirit of a witch. Arndt's dictionary (1961) does not indicate a Ngadha term for 'animal' (***cana wara***, corresponding lexically to Nage ***ana wa***, is glossed as 'snare for catching birds'), but this of course does not mean that none exists.

[5] The fact that ***ana*** is used in this way more often with reference to birds may be accounted for by the fact that, as Nage themselves recognize, for creatures identified with other named life-form taxa, notably ***nipa*** 'snakes' and ***ika*** 'fish', the life-form name can be used instead, at least when this much of an animal's identity is known.

[6] Takashi Sugishima, Kyoto University, personal communication 2000.

[7] Proto-Austronesian reconstructions include ***'uleg'*** and ***udaj*** 'worm' (listed by Wurm and Wilson, 1975 under 'maggot' and 'worm'); ****qulej***, glossed with Bahasa Indonesia *ulat* (Fernandez 1996:158); and ****ulaR*** 'snake, worm' (Zorc 1994:593). Fernandez (1996) has also reconstructed a 'Proto-Flores' form, ****uler*** (equated with Bahasa Indonesia *'ulat*, see Appendix 1).

[8] I follow Berlin's practice of employing "folk generic" (or simply "generic") to refer to ethnotaxa that comprise particular kinds mostly coinciding with scientific species or genera.

[9] Arndt glosses the last two terms, somewhat inexactly, as 'Sparrowhawk' and 'Eagle owl' (German *Uhu*). According to Verheijen (n.d.), ***ule polo*** refers to the Common koel (*Eudynamys scolopacea*). Evidence from Arndt's dictionary that ***ule*** can be used alone in the sense of 'bird' is the phrase ***ule léla dzére*** 'the bird flies suspended, hovers' (1933:86, s.v. ***dhére***; ***léla*** 'to fly').

[10] With regard to senses of *chong*, I am most grateful for assistance kindly provided by Dr. Lin Jenn-Shann of the Department of East Asian Studies, University of Alberta, and Dr. Wu Xu, a former doctoral student in the university's Department of Anthropology.

[11] Cecil Brown, who coined "wug" to refer to a life-form category comprising small creatures like 'bugs' and, frequently, 'worms' (1984:16), lists Mandarin *chung* as a 'wug' term, glossing it more specifically as 'insect+worm+nonsnake reptile' (Brown 1984:237).

[12] In combination, the affixes ***ku-*** and ***-ku*** lend a repetitive or continuous quality to the basic verbal compound, while ***ma-*** renders the nominal sense.

[13] It is a point of some interest, although one which cannot be fully developed here, that Verheijen (1967) lists Manggarai ***ular***, clearly a cognate of Malay/Bahasa Indonesia *ular* 'snake', as the name of a particular kind of snake and also as a component of six compounds (***u.-mandar, u.-mbani = u.-mbangi, u.-paka, u.-walok***) specifying other kinds of snakes.

[14] Blust (1983, "A Linguistic Key to the Early Austronesian Spirit World," unpublished manuscript), who does not cite this interpretation, treats ***kala wara*** and ***kala mango*** as reflexes of Proto-Austronesian reconstructions he collectively designates as "+qali/kali-forms." In a complex analysis, he argues that these forms, prefixed to other morphemes, once marked a variety of biological kinds and other natural entities as things associated with spiritual danger, or more generally as "referents, states or actions that were believed to be connected with the supernatural world" (Blust 1983:2). Whatever the merits of this argument, which is far too detailed to assess here, Blust evidently does not adduce the numerous Manggarai ***kaka*** compounds.

[15] Another ethnobiological instance of ***kala*** is as a general term for 'betel' (*Piper betle*), in which sense it further appears in compounds denoting varieties of betel as well as several other plants, including some that are considered to resemble betel (Verheijen 1967). However, it is not at all clear that ***kala*** in this context has the same derivation as the morpheme that appears in animal names.

[16] For Rembong, a language, or cluster of dialects, spoken to the northeast of Manggarai (and within the northwestern part of the present administrative region of Manggarai), Verheijen (1977) lists ***kokaq reman*** as a general term for 'wild animal', and in one dialect as a specific reference to a wild pig. (A comparable double meaning is found in ***kokaq kazu—kazu*** 'forest, wood'—glossed both as 'monkey' and 'animal'.) Further occurring in a variety of compounds referring to particular kinds of mammals, birds, insects, and snakes, ***kokaq***—glossed by Verheijen (1977) as 'animal; thing, object; person; unidentified object or person (Bahasa Indonesia *anu*)'—is evidently cognate with Manggarai ***kaka***. On the other hand, he translates ***reman*** as 'leaf (leaves); grass, weeds; undergrowth, scrub; forest'. Relevant here are words with similar meanings used in other languages, including Nage and Sumbanese, to refer to wild varieties of animals that also occur as domesticates (see, for example, Nage ***wawi witu*** and eastern Sumbanese ***wei rumba*** 'wild pig'). It is curious, however, that Verheijen glosses ***kaka remang***, the Manggarai cognate of Rembong ***kokaq reman***, not as wild animal but as 'livestock' (exemplified by horses and water buffalo). The Manggarai term specifying wild animals is ***kaka puar***, incorporating ***puar*** 'forest, jungle'.

[17] The ferns denoted by ***kaka kaju*** are epiphytic (see Appendix 2). The only comparable plant name recorded for Endenese is ***kaka rawa*** (*Dysoxylum*, Verheijen 1990). Lio includes no ethnobotanical compound terms which include ***kaka***, although in this language, also, the word has the sense of 'to wrap around, cling, adhere to' (Arndt 1933).

[18] Also consistent with an interpretation of ***kaka*** as, essentially, a nominalizing particle are ***kaka dagang*** or ***kaka wagang*** 'unidentified person; thing; genitalia' (apparently as a euphemism), as well as ***kaka tana*** 'earth spirit' (***tana*** 'earth'), assuming the first component is not a variant of another lexeme, ***kakar*** (see the synonymous dialectal ***kakar tana***).

[19] At present, ***kaka*** does not occur as a nominalizing particle in Nage or Ngadha. However, as already noted, most if not all of the central Flores compounds incorporating ***kaka*** can be accounted for in quite different ways.

[20] In a personal communication (22 February 2002), Ellen states that, at present, Nuaulu ***ipai*** is rarely used for 'animal' and is "increasingly replaced with ***binatan***" (cf. Malay *binatang* and the usages described above for Lio and Endenese). He also reports ***makapana*** as another general term for 'animal' (cf. Ellen 1993a:96, where this term is attributed to Rosemary Bolton, 1990). However, Bolton (pers. comm. 9 March 2003) states that ***makapana*** (from ***maka***, a nominal prefix, and ***pana*** 'to feed') refers specifically to domestic animals. Citing a Nuaulu informant whom she questioned in 2003 in Bandung (in Java), she has subsequently claimed (pers. comm. 27 March 2003) that ***ipai*** is not a Nuaulu word, or at least is not a general term for 'animal'. This apparent disagreement with Ellen is probably accounted for by the replacement of ***ipai*** with the loan word ***binatan***, which is noted by Ellen himself. An obvious cognate of ***binatan***, ***pinatane***, is reported by Margaret Florey (pers. comm. 4 December 2002) as the only term for 'animal' in the Alune language of western Seram.

[21] According to Adelaar (1994:13), a method comparable to employing a descriptive phrase is the use of a word meaning 'game' or 'meat' to denote 'animal'. Although it does not name animals in general, it is a point of interest that ***nake*** (usually 'meat' or 'game' in central Flores languages) is listed as a general term for 'bird' in Endenese (Aoki and Nakagawa 1993; Suchtelen 1921:340, 389).

[22] Although my discussion has been restricted to Austronesian languages, it is noteworthy that Taylor (1990:49, 50, 67) reports a term for 'animal' in the non-Austronesian Tobelo language, spoken on the eastern Indonesian island of Halmahera. This is ***aewani***. Since Taylor provides no interpretation of the term, it is presumably unanalyzable.

[23] I use 'unanalyzable' in the general sense. In contrast, Berlin et al. (1974:28) employ 'analyzable' and 'unanalyzable' in a way largely restricted to taxonomic relations. Thus, in their typology of lexemes, Nage ***ana wa*** 'animal' would be classified as an 'unproductive analyzable primary lexeme', since the second element (***wa*** 'wind') does not specify the term as labelling a taxon subordinate to one designated by the first element (***ana*** 'child, person'; cf. Taylor 1990:40, for a critical discussion of Berlin's typology). To the extent that he employs this typology in his 1992 book, Berlin (1992:27–28) speaks of "names" rather than "lexemes," while he replaces "unanalyzable" and "analyzable" with "simple" and "complex."

[24] As has often been recognized, English 'animal' can contrast for example with 'bird' or (according to Wierzbicka 1985) 'snake' (see Forth 1995:66, n. 2).

[25] Although the matter cannot be explored in this paper, there is perhaps also a question of whether widespread life-form terms, such as those reflecting Proto-Malayo-Polynesian ****manuk*** 'chicken, bird, fowl' (Zorc 1994:583; see also Proto-Austronesian ****manuk*** 'bird', Bellwood 1997:102, Table 4.1), or indeed the protoform itself, are, or were, as consistently

inclusive as English glosses, such as 'bird', would suggest. Since Bima-Sumba reflexes of ***manuk** (such as Nage and Sumbanese **manu**), when used without modification, refer only to the domestic fowl, one is also led to ask, with regard to Berlin's evolutionary thesis, whether the apparent loss of this lexeme as the name of a life-form taxon should be understood as an instance of regression, or devolution.

[26] Sexual and reproductive behavior is another feature that sets animals apart from other living and nonliving things. Yet, for Nage and other folk biologists, this is not so evident or observable as is movement and, indeed, for animal kinds that are rarely or never observed mating, is mostly attributed on the basis of inference.

Nage, Sumbanese, and other eastern Indonesians apply terms for 'living' and 'dead' equally to plants and animals. Indeed, the idea that plants are 'living things' is probably universal, and, as Bloch (1998) has recently pointed out, is arguably part of the reason that plants (including trees) are, like animals, widely employed as human metaphors. This is not to say, however, that this common quality is a sufficient basis for the recognition of plants and animals—or, indeed, human beings (usually, and in a sense universally, distinguished from animals)—as members of a superordinate taxon of 'living things', as is implicit in the western scientific concept of a 'biology' equally subsuming 'botany' and 'zoology'.

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APPENDIX 1.—Cognates of Lio ***ule*** in other Flores and eastern Indonesian languages.

'Proto-Flores'	***uler** = Bahasa Indonesia '*ulat*' (Fernandez 1996: 158; cf. Proto-Austronesian ****qulej,*** ibid.; cf. ?PAN ****ulaR*** 'snake, worm', Zorc 1994: 593)
Manggarai	***uli*** (dialectal ***ules, ulos***; Verheijen 1982: 131), 'maggot' (and apparently similar creatures, Verheijen 1967)
Komodo	***uleh, uler*** 'maggot, type of worm' (Verheijen 1982: 131)
Ngadha	***ule*** 'maggot, worm, caterpillar' (Arndt 1961)
Nage	***ule*** 'maggot, worm, grub' (Forth, field notes)
Endenese (Nga'o dialect)	***ule*** (=***oelech***) 'caterpillar' (van Suchtelen 1921)
Endenese (Ja'o dialect)	***'urhe*** 'worm' (Aoki and Nakagawa 1993: 92)
Sika	***ule*** (=Bahasa Indonesia *ulat*; see also ***ule lale, ule nale*** 'sea-worms'; ***ule klobat*** 'cocoon'; ***ule tana*** 'worms that eat maize roots' Pereira & Lewis 1998: 203)
Tetum	***ular*** 'worm, caterpillar, larva' (Morris 1984: 193; 'fly maggot' is labelled with another term); 'worm, caterpillar; crawling insect' (Hull 2001)

Note: Several dictionaries which employ Bahasa Indonesia (the Malay-based Indonesian national language) as the target language simply gloss the local word as *ulat.* Echols and Shadily (second edition, 1963) list ***ulat*** as: '1. caterpillar 2. worm, insect' (cf. *ulat serangga,* insects; cf. *serangga,* insect). The third and revised edition of their dictionary (1989) gives '1. caterpillar, worm (in compounds) 2. maggot, larva'.

APPENDIX 2.—'KAKA' compounds denoting living kinds in Manggarai and other languages of Flores.

a) KAKA compounds in Manggarai (Verheijen 1963, 1967)

Note: Not all names incorporating ***kaka*** appear in all Manggarai dialects. Also, in some dialects, the same zoological kinds are named with terms which do not incorporate ***kaka***. Glosses of second components are from Verheijen 1967 and 1963: 716–717 (see "Summary ad hoc translation of Manggarai words"); (ON) indicates that, according to Verheijen (1968), the second term is onomatopoeic. (Onomatopoeic terms can be understood either as names for the sound or as verbs meaning to produce the sound in question.) All terms follow Verheijen's orthography. For the sake of comparison, however, it should be noted that /dj/ corresponds to /j/ (cf. /j/ in English 'jaw') in the transcription of other Indonesian languages discussed in this paper, and /tj/, similarly, to the sound written as /c/ (cf. English /ch/ as in 'chat').

kaka ando aék waé, kind of dragonfly (provisional identification) (***ando aék*** 'to bend over, bow'; ***waé*** 'water, river')

kaka awa, a kind of spider (also simply ***awa***)

kaka bégol, a kind of poisonous snake (***bégol*** 'to throw, hurl'. According to Verheijen, under the synonym ***metjo***, this snake is said to be able to spring or jump; the name therefore probably refers to Russell's viper, see Forth 1995:52–53, s.v. ***ba bago***)

kaka dangka 'earwig, locust' (referents unclear; cf. Komodo ***kaka dangka***, below) (= ***iko dangka***; ***iko*** 'tail'; ***dangka*** 'branch, fork; hook; branch off, diverge', evidently referring to the shape of the tail)

kaka éa, Flores crow (*Corvus florensis*) (ON)

kaka djurit, Bushlark (*Mirafra javanica*) (***djurit*** 'to run'; the bird in question characteristically runs along the ground)

kaka kedéngké or ***kaka koé koé***, Pitta (*Pitta brachyura*) (***kedéngké*** 'to hop'; ***koé*** 'small')

kaka kék, White-breasted wood-swallow (*Artamus leucorhynchos*) (ON)

kaka kéntu, a species of falcon and a species of hawk (*Accipiter*). (***kéntu***, harvesting knife for rice; to cut, sever; cf. Nage ***bele teka*** 'sharp wing' as a name for a falcon; Forth 1996)

kaka ketok, Sunda pygmy woodpecker (*Dendrocopos moluccensis*); Great tit (*Parus major*, Méngé dialect) (***ketok*** 'to knock, tap')

kaka kiong, Bare-throated whistler (*Pachycephala nudigula*; also called simply ***kiong***) (ON)

kaka kuik, *Cisticola* spp. (small birds) (ON)

kaka langu, toxic mushroom (cf. ***langu*** 'to intoxicate', 'to act as though drunk')

kaka langu waé, sort of freshwater insect (***waé*** 'water, river')

kaka lawar, Apodidae and Hirundinidae (swifts and swallows; also simply called ***lawar***; cf. Malay/Bahasa Indonesia *kalewar*, bat; eastern Sumbanese ***kalewaru***, swiftlet, *Collocalia* spp. Forth 2000)

kaka leka, kind of poisonous snake (also simply ***leka***, described as a speckled snake; cf. ***leka***, palm bough, dried palm leaf used as decoration)
kaka léros, 'birds with cup-shaped nests', generally Zosteropidae (white-eyes). (***léros*** 'yellow')
kaka lunteng, kind of grayish black snake that eats frogs and rodents (cf. ***lunteng*** 'large piece of firewood')
kaka mésé, literally 'large creature', eagles (general term), also 'water buffalo' (***mésé*** 'big')
kaka muntung, dark phase of *Spizaetus cirrhatus* or other dark eagles (***muntung*** 'burned, dark-colored')
kaka nanong, kind of small insect resembling a spider; (dialectal) water strider, Gerridae (***nanong*** 'to go up and down')
kaka ndurut, kind of insect (***ndurut*** 'to hang, be suspended; (of a tree) packed with fruit')
kaka ngé'ok, kind of worm (***ngé'ok*** 'to move the body repeatedly')
kaka nteleng, kind of insect similar to a wasp and the size of a fly (***nteleng*** 'still, motionless')
kaka pémpang, kind of flying insect resembling a mosquito (***pémpang*** 'fever, malaria')
kaka petju, sort of malodorous insect, *Pherosophus* sp. (***petju*** 'to fart')
kaka rae, Red cuckoo-dove (*Macropygia phasianella*; also simply called ***rae*** or ***rae-rae***) (***rae*** 'reddish color, brown')
kaka rawuk, kinds of hawks (*Accipiter* spp.; synonymous or overlapping with ***kaka kéntu***) (***rawuk*** 'ash, gray')
kaka sara, centipede, Geophilidae (***sara***, kind of creeper growing in underbush)
kaka ta'a, Green tree viper (***ta'a*** 'half-ripe, green')
kaka téi or ***kaka tik***, Brush cuckoo (*Cacomantis variolosus*) (ON)
kaka teret, Bee-eater (*Merops superciliosus*) (ON)
kaka toak, Common koel (Eudynamis scolopacea) (ON)
kaka wadja, crocodile (cf. ***wadja*** = Malay/Bahasa Indonesia *baja* 'steel, armor; hard iron')

b) KAKA compounds in Nage

kaka daza, Dollarbird (*Eurystomus orientalis*)
kaka hika, Flying lizard (*Draco* sp.; Van Suchtelen 1921 records ***kaka héka*** for the Nga'o dialect of Endenese, while Arndt 1961 lists ***héka***, transcribed as ***xéka***, as 'to have arms or wings')
kaka kea, Yellow-crested cockatoo (*Cacatua sulphurea*), also called simply ***kea***
kaka koda, Praying mantis
kaka meo, one or more species of large spiders (cf. ***meo*** 'cat')
kaka watu, kind of freshwater fish (***watu*** 'stone')

c) KAKA compounds in Ngadha (from Arndt 1961, except where otherwise indicated)

Note: I employ the same orthography as I use for Nage. Where Arndt's usage differs from this, his transcription is placed in brackets.

kaka, edible crab; ringworm (***kaka*** also occurs as a reference to a skin disease in the Ja'o dialect of Endenese, Aoki and Nakagawa 1993)
kaka bheto, edible plant 'with with sourish leaves' (Verheijen 1990; thus *Dysoxylum* sp.; cf. Endenese ***kaka rawa***, *Dysoxylum*, ibid.)
kaka daza, kind of bird (cf. Nage ***kaka daza***)
kaka kaju (***kaka kadju***), vine(s), fern(s) of the genus *Asplenium,* tree(s) of the genus *Ficus* (Verheijen 1990)
kaka kuwe (***kaka kuve***), heron (***kuve*** 'speckled black and white')
kaka meo (***kaka méco***), large spider

d) KAKA compounds in Komodo (from Verheijen 1982)

kaka dangka, earwig
kaka kéaq, Barn owl (*Tyto alba*)
kaka po, Large-billed crow (*Corvus macrorhynchus*)
kaka rao, Glossy swiftlet (*Collocalia esculenta*); possibly also Drongo (*Dicrurus* sp.)
kaka wetoq, Sunda pygmy woodpecker (*Dendrocopos moluccensis*)
kaka koaq, Helmeted friarbird (*Philemon buceroides*)

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OJIBWAY PLANT TAXONOMY AT LAC SEUL FIRST NATION, ONTARIO, CANADA

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ABSTRACT.—Ojibway (Anishinaabe) Elders of Lac Seul First Nation who are fluent in the Oji-Cree dialect and knowledgeable about plant names were interviewed. They provided names of 38 plant taxa, with some synonyms. The study also identified 65 Oji-Cree plant-related phrases, nouns, suffixes, and prefixes. There is no word for 'unique beginner' that corresponds with the plant kingdom. Plant classification at Lac Seul is based on gross morphology, but also reflects traditional utilization of the plants. The Lac Seul people do have names for two overlapping all-inclusive categories representing trees and all deciduous plants. There are five named and covert life-form taxa that are clearly morphologically defined: 'conifer' (covert), 'angiosperm tree' (covert), 'shrub', 'herb, fern or fern ally' and 'moss'. Two additional plant groupings, 'medicinal root' and 'berry', reflect cultural utility and overlap with the five principal life forms. Although unnamed, one additional grouping, 'bark plants', was identified that is also based on cultural utility. It was found that the names of certain ubiquitous species are the same in Lac Seul Oji-Cree and in other Algonquian languages ranging from northern Saskatchewan to western Quebec.

Key words: ethnobotany, folk taxonomy, Ojibway, Anishinaabe, boreal forest.

RESUMEN.—Se entrevistó a varios ancianos Ojibway (Anishinaabe) de la etnia indígena Lac Seul, que hablan con fluidez el dialecto Oji-Cree y son buenos conocedores de los nombres de las plantas. Ellos facilitaron los nombres de 38 táxones vegetales, con algunos sinónimos. El estudio identificó además 65 dichos, nombres, sufijos y prefijos relativos a las plantas en Oji-Cree. No hay ninguna palabra que corresponda al 'reino vegetal'. La clasificación vegetal entre los Lac Seul se basa en la morfología general, pero también refleja la utilidad tradicional de las plantas. Las gentes Lac Seul tienen nombres para dos categorías superpuestas que incluyen todos los elementos dentro de 'árboles' y 'plantas de hoja caduca'. Hay cinco táxones de biotipos bien definidos morfológicamente; algunos se nombran y otros no: 'conífera' (no nombrado), 'angiosperma arbórea' (no nombrado), 'arbusto', 'herba, helecho o similar' y 'musgo'. Dos grupos adicionales de plantas, 'raíz medicinal' y 'frutillo silvestre,' reflejan una utilidad cultural y se superponen a los cinco biotipos principales. Existe además una agrupación adicional, no nombrada, de las 'plantas que producen corteza', basada también en utilidad cultural. Se constató que los nombres de ciertas especies ubicuas son iguales en Oji-Cree de Lac Seul y en otras lenguas Algonquian extendidas desde el norte de Saskatchewan al oeste de Quebec.

RÉSUMÉ.—Les aînés ojibwés (Anishinaabe) de la Première Nation Lac-Seul qui parlaient couramment le dialecte oji-cri et qui connaissaient bien les noms des plantes ont été interviewés. Ils nous ont communiqué 38 noms de plantes, ainsi que quelques synonymes. Cette étude a également permis de déterminer 65 phrases, noms, suffixes et préfixes ojibwés liés aux plantes. Il n'existe aucun terme pour «royaume populaire» correspondant au règne végétal. Au Lac-Seul, la classification végétale est fondée sur la morphologie grossière; elle est également le reflet de l'utilisation traditionnelle des plantes. Les habitants de Lac-Seul possèdent des noms pour deux grandes catégories inclusives qui se chevauchent, dont l'une représente les arbres, l'autre englobe toutes les plantes à feuillage décidu. Il existe cinq taxons ayant des noms oji-cris et qui portent sur des formes de vie cachées. Ils sont clairement définis sur le plan morphologique: «conifère» (caché), «arbre angiospermien» (caché), «buisson», «herbacée», «fougère» ou «plante affine» et «mousse». «Baie» et «plantes médicinales» forment deux autres groupes de plantes. Ces groupes sont fondés sur l'utilisation culturelle et chevauchent les cinq principales formes de vie. Quoique ne portant pas de nom, un groupe additionnel a pu être identifié qui correspond aux «plantes à écorce». Il s'agit aussi d'un groupe fondé sur les utilisations culturelles. Finalement, il ressort de cette étude que le nom de certaines espèces ubiquistes ne diffère pas entre le dialecte de la communauté du Lac-Seul et celui des autres groupes algonquiens dispersés entre le nord de Saskatchewan et l'ouest du Québec.

INTRODUCTION

This study focuses on folk plant classification of the Oji-Cree speaking Ojibway (Anishinaabe) people in northwestern Ontario at Lac Seul First Nation, Lac Seul, Ontario, Canada. While considerable information regarding Ojibway and Cree plant names is known (Densmore 1928; Leighton 1985; Meeker et al. 1993; Smith 1932), there has been no study of the plant classification system of the Anishinaabe in northwestern Ontario. The purposes of this preliminary and modestly funded study were to document plant names and plant category terms in the Oji-Cree language at Lac Seul First Nation in northwestern Ontario, Canada; to determine how the plants are classified; and to compare the Lac Seul plant nomenclature with other nonagrarian North American Algonquian folk systems. Only a small percentage of the on-reserve population retains the Oji-Cree language. Most of these people are Elders over 60 years old.

Geographic Setting and Vegetation.—Lac Seul First Nation is situated on the south shore of Lac Seul at approximately 50°09′ north latitude and 92°12′ west longitude. The total land area is inexact due to fluctuating water levels from the dam at Ear Falls, Ontario, but it is estimated to be 27,287 ha (67,375 acres).

Lac Seul lies within the Upper English River section of the boreal forest region (Rowe 1972). This area represents a transition zone between the Great Lakes-Saint Lawrence forest to the south and the boreal forest to the north. The vegetational regimes at Lac Seul show typical boreal diversity due to a continuum of patch disturbances by fire, blowdown, and insect infestation. In addition, human activity has created long-term modifications in the forest. To this day people create habitation sites, trails, and portages.

The Ojibway (Anishinaabe) of Lac Seul.—From archaeological remains, it is known that aboriginal people have occupied the region of Lac Seul and the English River watershed for about 9000 years (Dawson 1983). Anishinaabe people resided on

Lac Seul when the first European fur traders came into the waterways. The language spoken at Lac Seul is a dialect of Oji-Cree, a blend of two Algonquian languages.

From precontact times to first contact with European traders in the 1750s and well into the latter half of the twentieth century the Lac Seul Anishinabe have maintained a fishing, hunting, and gathering culture of the Boreal and Great Lakes-St. Lawrence ecosystems. This transition zone was rich and varied in food resources before Lac Seul was flooded to create a reservoir by a joint agreement between Canada and the United States (first in the early 1930s and again in the 1950s). The once extensive wetlands supported wild rice beds and high waterfowl populations, extensive fish spawning grounds, muskrat and beaver habitat, and they supported many wetland plants used for food and medicine.

MATERIALS AND METHODS

Knowledge of many of the Oji-Cree names for plants and their uses persists only among a few older residents at Lac Seul. Interviews were conducted sporadically from 1997 to 1999 with Elders known for their knowledge of the local plants. Plant identification was based on pressed or fresh specimens presented to the respondents.[1] Questions were presented in Oji-Cree with the help of a translator who was a resident of the community. In addition to the traditional names of specific plants and plant groups, respondents were asked about traditional economic uses and the relationships of plants to each other. Details of the plant collection and interview process are presented in Kenny (2000).

Berlin's (1992) modified Venn diagrams are used to present the plant classification at different hierarchical levels. All ethnobotanical taxa are represented by gray circles and labeled in bold italics. Botanical taxa are represented by black circles, usually at the genus or species level, and labeled in italics. Hierarchical relationships are shown by nesting the circles representing taxa. Where taxa are interpreted to converge (i.e., they are not mutually exclusive), the circles overlap. Where taxa are covert (unnamed), the circle is a dashed line.

RESULTS

As has been found in other folk taxonomies, there apparently is no all-encompassing word for 'plant' at Lac Seul; the covert kingdom Plantae is inferred from descriptive vocabulary (Berlin 1992). This study identified a total of 65 Oji-Cree plant-related phrases, nouns, suffixes and prefixes that were collected from respondents at Lac Seul First Nation.[2] These 65 names and phrases identify 38 botanical taxa (Table 1) and 19 morphological characteristics of plants (Table 2). A list of the plant taxa is provided in Table 1 with Oji-Cree translations.

Table 1 also lists the synonyms encountered when respondents offered different names for the same plant. When synonyms were revealed, one name expressed an attribute of the plant and the other described a use of that plant. For example, *Cornus stolonifera* is named ***paashkoaatig*** 'scraping (inner bark) for use' and ***miskaabemig*** 'visible (from a distance) because of its redness'; *Diervilla lonicera* is named ***ozhaawaapimaatig*** 'green bark shrub' and ***ozhaawaakiimiinaatig***

TABLE 1.—Plant taxa from Lac Seul First Nation, Ontario, Canada.

Taxon[1]	Oji-Cree	English translation	Common English name
Abies balsamea (L.) Mill.	***shingob bigiw***	fir/spruce with gum	balsam fir
Acer spicatum Lam.	***zshaashaagopemaagaatig*** (n.)	'chewing wood (shrub)'	mountain maple
	zshaashaagopemigoon (v.)	'chewed upon this wood has been'	
Achillea millefolium L.	***waabigooniinzens***	'flower which is little'	yarrow
Acorus calamus L.	***achiitemoo azoo***	'squirrel tail'	sweet flag
	wiikensh	no translation	
Alnus crispa (Ait.) Pursh.	***moozpaagoon***	'(like the) hanging moose bell'	green alder
Amelanchier spp.	***zhigaagomiinen***	'skunk = saskatoon berry'	saskatoon berry
	zhigaagomiinaatig	'skunk = saskatoon berry wood (shrub)'	
Anaphalis margaritacea (L.) Benth & Hook.	***agawaapamakiin***	'when it comes out in the day-light'	pearly everlasting
Apocynum androsaemifolium L.	***mahkwa ochiibig***	'bear's root'	spreading dogbane
	osheysep	'for twine'	
Aralia nudicaulis L.	***waabooz ochiibig***	'rabbit's root'	wild sarsaparilla
Arctostaphylos uva-ursi (L.) Spreng.	***menozhaatig***	'healing wood (shrub)'	bearberry, kinnikinnik
Betula papyrifera Marsh.	***wiigwaas***	no translation	white birch
Clintonia borealis (Ait.) Raf.	***zhaashaagomiinaatig*** (n.)	'chewable berry wood (shrub)'	blue bead lily
	shaashgobuteh (v.)	'(it is) going through (the body)'	
Coptis trifolia (L.) Salisb.	***osawa ochiibigens***	'yellow root little'	goldthread
Cornus canadensis L.	***zhaashaagomiinen***	'chewing berries'	bunchberry
Cornus stolonifera Michx.	***paashkoaatig***	'scraping it (bark) to use shrub'	red osier dogwood
	miskaabemig	'being red it is visible'	
Corylus cornuta Marsh.	***bigaanaatig***	'nut wood (shrub)'	beaked hazel
Diervilla lonicera Mill.	***ozhaawaapimaatig***	'green bark shrub'	bush honey-suckle
	ozhaawaakiimiinaatig	'green innerbark berry shrub'	
	wiikaasenseywin	'being peelable'	
Epilobium angustifolium L.	***shiingibiishkag***	'like the fish duck' (red grebe)	fireweed
Eupatorium perfoliatum L.	***aazhaabaakesiing***	'(stem) going right through'	boneset

TABLE 1—(continued)

Taxon[1]	Oji-Cree	English translation	Common English name
Fraxinus nigra Marsh.	***aagemag***	no translation	black ash
Gaultheria hispidula (L.) Muhl.	***amiinaadekag***	'leaf/berry that smells good'	creeping snowberry
Inonotus obliquus (Fr.) Pil.	***saagaategun***	'in the light'	
Linnaea borealis L.	***paapiishaagakiig***	'(flowers) come in later in the summer'	twinflower
Picea spp.	***shingob***	no translation	white or black spruce
Pinus spp.	***zhingwaak***	no translation	red or white pine
Pinus banksiana Lamb.	***kik***	no translation	jack pine
Populus spp.	***azaadii***	no translation	trembling aspen or balsam poplar
Pteridium aquilinum (L.) Kuhn	***ginebigoon***	'snake place'	bracken fern
Sambucus pubens Michx.	***wiimbashkwaatig***	'bursts off the stem wood' (bark)	red elderberry
Sorbus decora (Sarg.) Schneid.	***mahkwaomiinaatig***	'bear's berry wood'	showy mountain ash
Sphagnum spp.	***waabangaamig aaki*** ***ikwewaabangaamig***	'earth white ground cover' 'woman white ground cover'	sphagnum or peat moss
Class Bryidae ('true mosses')	***ozhaagaamig***	'green ground cover'	feather moss
Thuja occidentalis L.	***kiizhig***	no translation	eastern white cedar
Usnea cavernosa Tuck.	***miishiigan***	'hairy thing' (used for lichens hanging from trees)	old man's beard
Vaccinium spp.	***miin***	'blueberry'	blueberry
Vaccinium angustifolium Ait.	***miinens***	'little blueberry'	low sweet blueberry
Vaccinium myrtilloides Michx.	***michaa miin***	'large blueberry'	velvet leaf blueberry

[1] Nomenclature follows Baldwin and Sims (1989) and Gleason and Cronquist (1963).

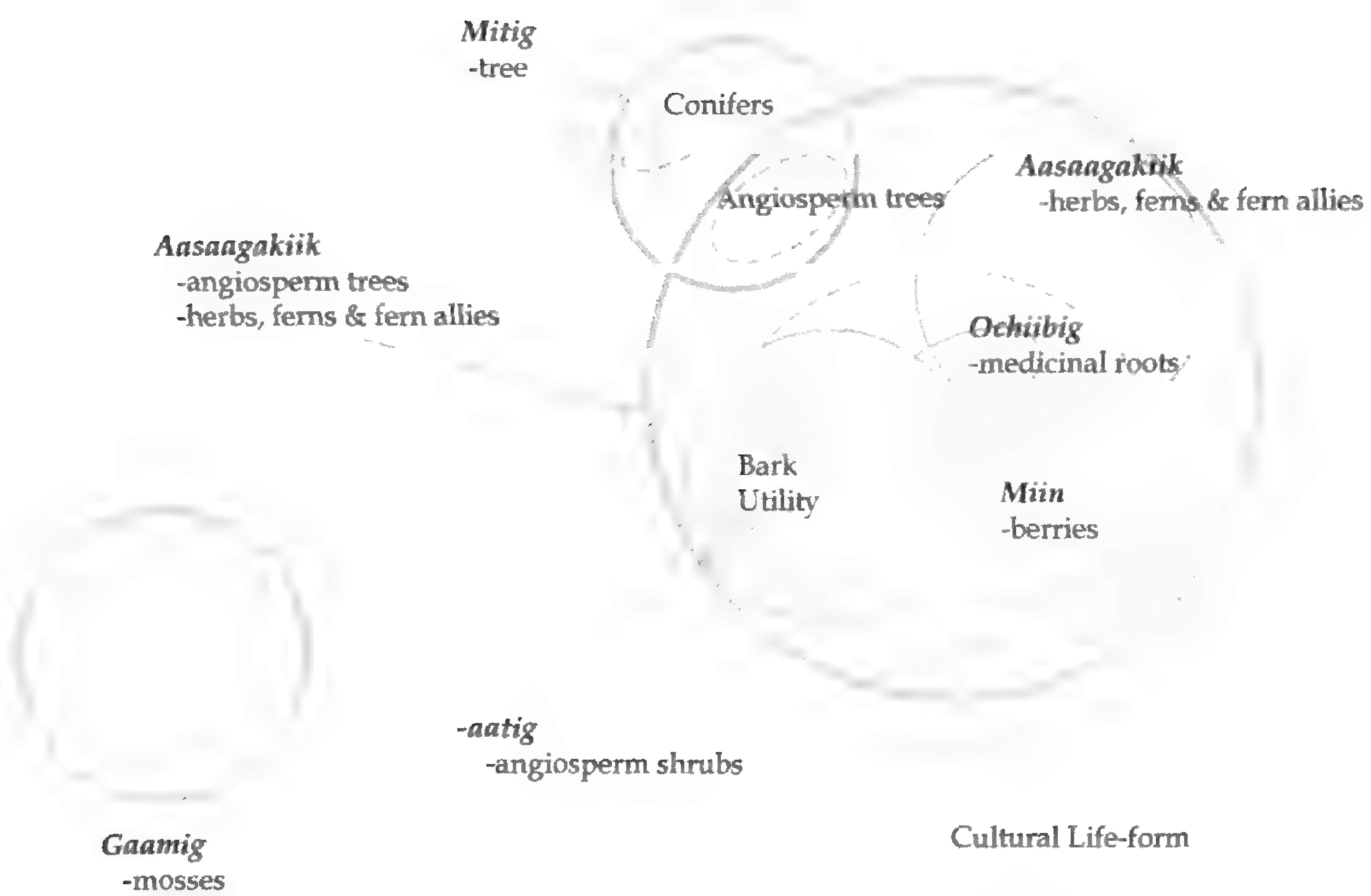

FIGURE 1.—Lac Seul life-form taxa and overlapping culturally-based groups.

'green inner bark, berry shrub'. *Apocynum androsaemifolium* is named ***mahkwa ochiibig*** 'bear's root'; ***osheysep*** 'for twine' refers to its root or stem. *Clintonia borealis* is named both ***shaashgobuteh*** '(it is) going through the body', which refers to its medicinal activity as a laxative, and ***zhaashaagomiinaatig*** 'chewable berry shrub'.

The highest ranking plant groups are represented in Figure 1. The two somewhat overlapping life-form groups which include vascular plants are ***mitig*** 'tree', which includes all trees, and ***aasaagakiik*** *sensu lato* (s.l., in the broad sense) which contains nonconiferous woody plants and herbs, together with ferns and fern allies. While the noun ***mitig*** denotes all trees, the focus of this term is primarily conifer species reflecting the composition of the boreal forest vegetation at Lac Seul (Rowe 1972). The noun ***aasaagakiik*** s.l. defines a large part of the domain of plants. According to one respondent, ***aasaagakiik*** s.l. is explained as "all things which grow up out of the ground, change and die." The deciduous conifer, *Larix laricina* (Du Roi) K. Koch, is probably excluded from this group.

Five additional life-form taxa are 'conifer', 'deciduous tree', 'shrub', 'herbaceous plant' (which includes ferns and fern allies), and 'moss'. Each of these groups is polytypic since each encompasses more restricted named taxa.

Coniferous and angiosperm trees are recognized as distinct entities by the Lac Seul people. Both types are included in the designation ***mitig*** 'tree', but only angiosperm trees are also included within ***aasaagakiik*** s.l.—angiosperms and fern allies (Figure 1). 'Conifer' may be thought of as a covert intermediate life-form taxon inferred from the vocabulary describing parts of coniferous trees (Table 2): ***opii*** 'conifer needle', ***ozhiigoopiin*** 'needled branch of conifer' (usually spruce and fir) and ***bigiw*** 'spruce or fir gum'. 'Deciduous tree' is also a covert intermediate life-form taxon being described by a respondent as ***aasaagakiik*** (i.e., separate from the conifers).

The covert life-form groups 'conifer' and 'angiosperm trees' are shown with

TABLE 2.—Morphological vocabulary describing plants in Lac Seul Oji-Cree.

English	Oji-Cree
Nouns	
berry	***miin***
leaf	***niibish***
inner bark (with sap and latex)	***oshiiban***
root	***ochiibig***
needled branches of pine	***ozhiigoopiin***
needled branches of spruce/fir	***bigiwoopiin***
gum	***bigiw***
nut	***bigaan***
flower	***waabigwan***
tree	***mitig***
plant—that grows, changes and dies (herbaceous and/or woody deciduous plant)	***aasaagakiik***
Suffixes	
wood/shrub	***-aatig***
root	***-ochiibig***
berry	***-omiinen***
conifer needle	***-opii***
moss, lichens	***-gaamig***
Prefixes	
chewing	***zhaashaa-***
yellow	***osaa-***
green	***ozhaa-***
red	***miska-***

associated genera (Figure 2). The covert 'conifer' life form contains four genera. ***Shingob*** contains both *Picea glauca* (Moench.) Voss and *Picea mariana* (Mill.) B.S.P. as well as *Abies balsamea.* The two undifferentiated botanical *Picea* species are an example of the botanical "type concept" for the folk genus ***shingob***. ***Shingob*** is the type species for the genus while ***shingob bigiw*** is a binomial referring to the folk species 'gummy ***shingob***' (*Abies balsamea*). ***Zhingwak*** contains both *Pinus resinosa* Ait. and *Pinus strobus* L. but excludes *Pinus banksiana,* which is called ***kik***.

The covert life form 'angiosperm trees' contains four folk genera: ***aagemag*** (*Fraxinus nigra*), ***azaadii*** (*Populus* spp.), ***moozpaagoon*** (*Alnus crispa*), and ***wiigwaas*** (*Betula papyrifera*). ***Azaadii*** includes both *Populus balsamifera* and *Populus tremuloides. Alnus crispa* (***moozpaagoon***) has an intermediate stature between a tree and a shrub at Lac Seul. Since it is not modified by the "shrub" suffix ***-aatig***, so it is grouped with 'angiosperm trees'.

Plants with names having the suffix ***-aatig*** constitute the life form 'shrub' (also translated as 'wood'), and are included in the designation ***aasaagakiik*** s.l. (Figure 1). We have been unable to determine if ***-aatig*** also refers to coniferous shrubs such as *Juniperus communis* L. and *Taxus canadensis* Marsh., which are present at Lac Seul. The names of nine folk genera, eight of which are considered shrubs, have the suffix ***-aatig*** (Figure 3). The eight characteristic members of the group ***-aatig*** are ***zshaashaagopemaagaatig*** (*Acer spicatum*) ***zhigaagomiinaatig*** (*Amelanchier* spp.), ***menozhaatig*** (*Arctostaphylos uva-ursi*), ***paashkoaatig*** (*Cornus sto-*

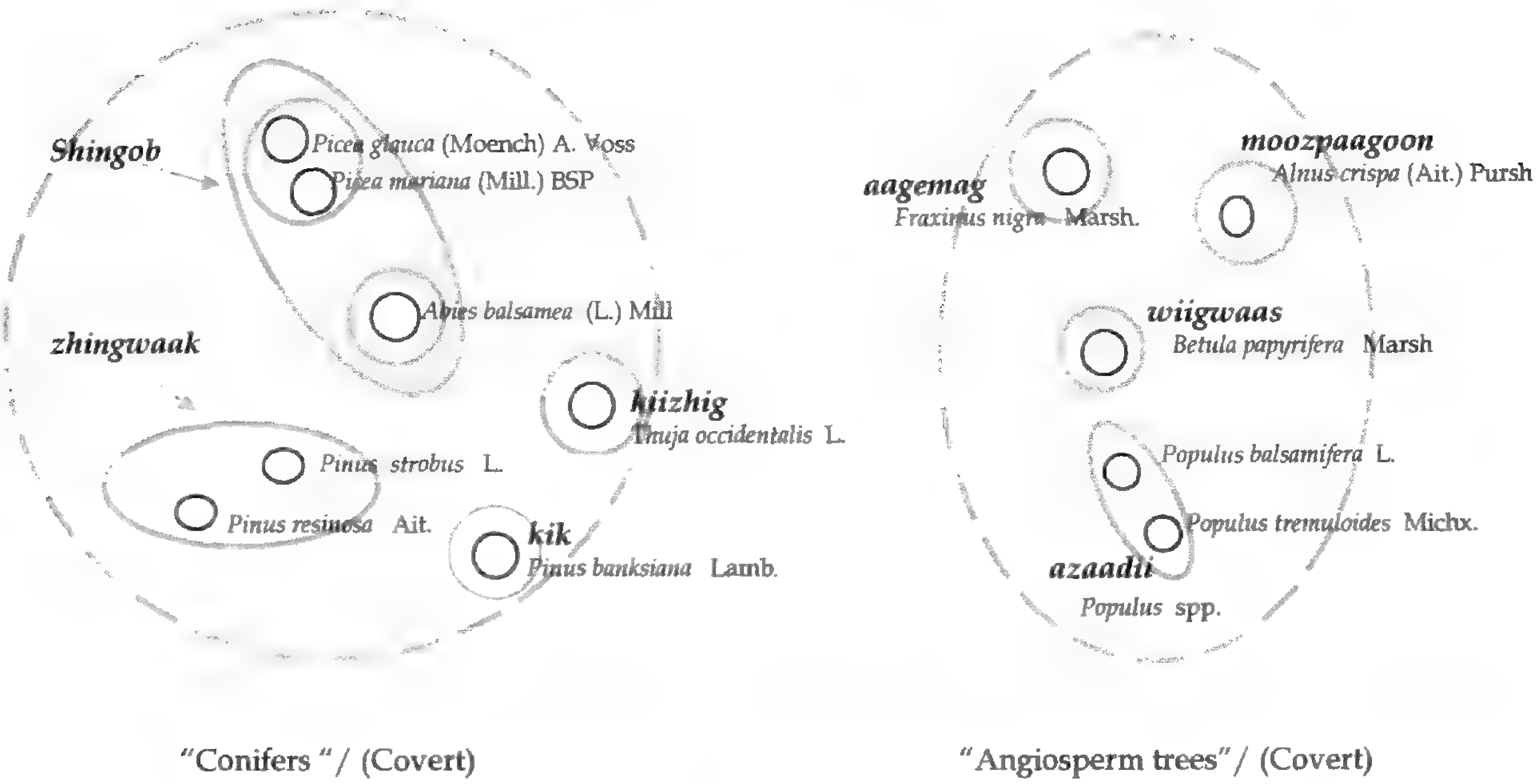

FIGURE 2.—Lac Seul covert life forms: conifers and angiosperm trees with nested folk generic and folk specific taxa.

lonifera), **bigaanaatig** (*Corylus cornuta*), **ozhaawaapimaatig** (*Diervilla lonicera*), **wiimbashkwaatig** (*Sambucus pubens*), and **mahkwaomiinaatig** (*Sorbus decora*) (see Table 1 for English translation of Oji-Cree). The name of one aberrant nonwoody folk genus also includes the **-aatig** suffix; **zhaashaagomiinaatig** (*Clintonia borealis*) is a low, herbaceous member of the Liliaceae. It has not been determined why this anomaly exists.

The life form **aasaagakiik** is polysemous, being applied at more than one taxonomic rank. Besides referring to all deciduous plants including trees when used in the broad sense, the same word is also used in a more restricted context,

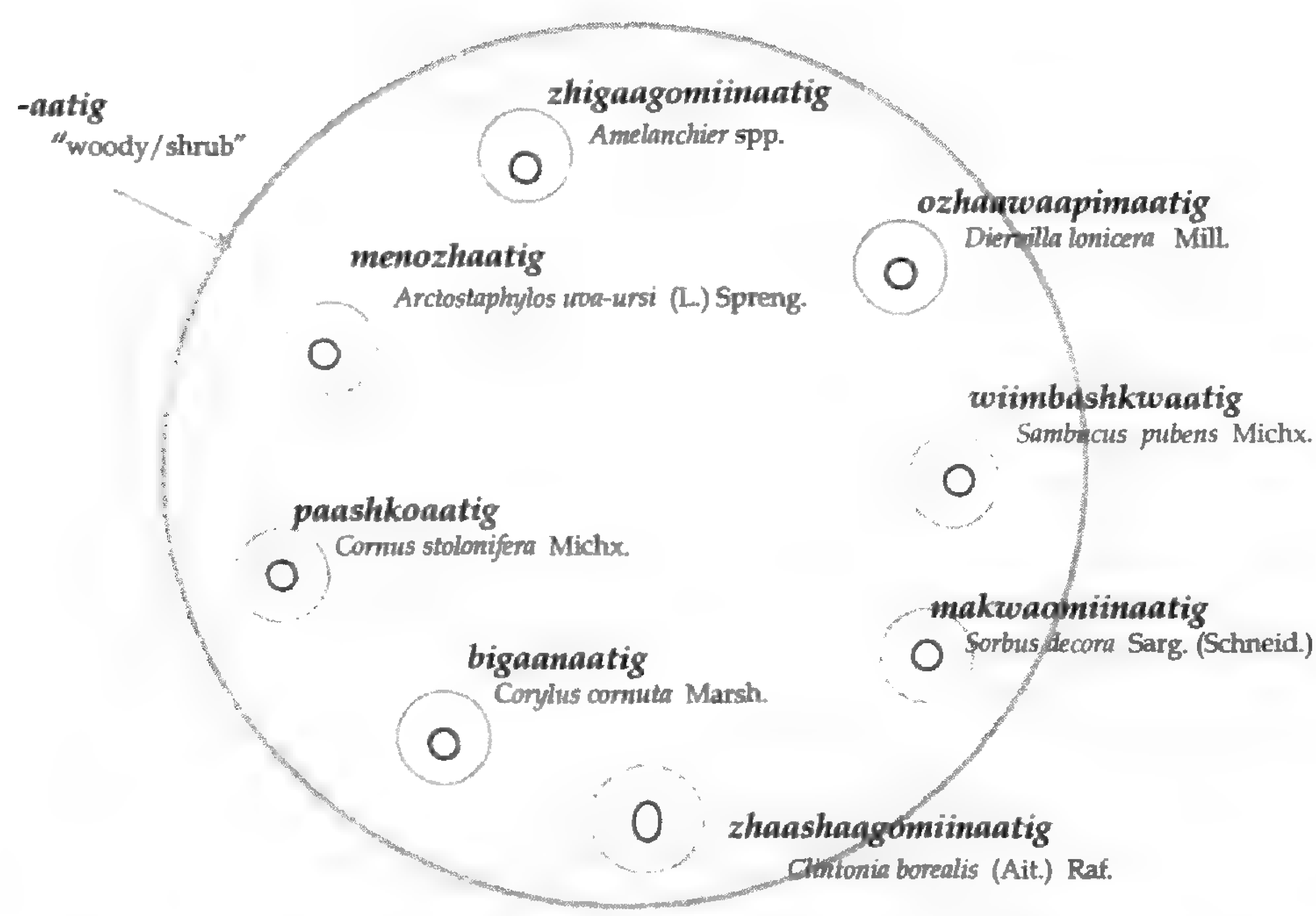

FIGURE 3.—The Lac Seul life form **-aatig**, (shrub) with nested folk generic taxa.

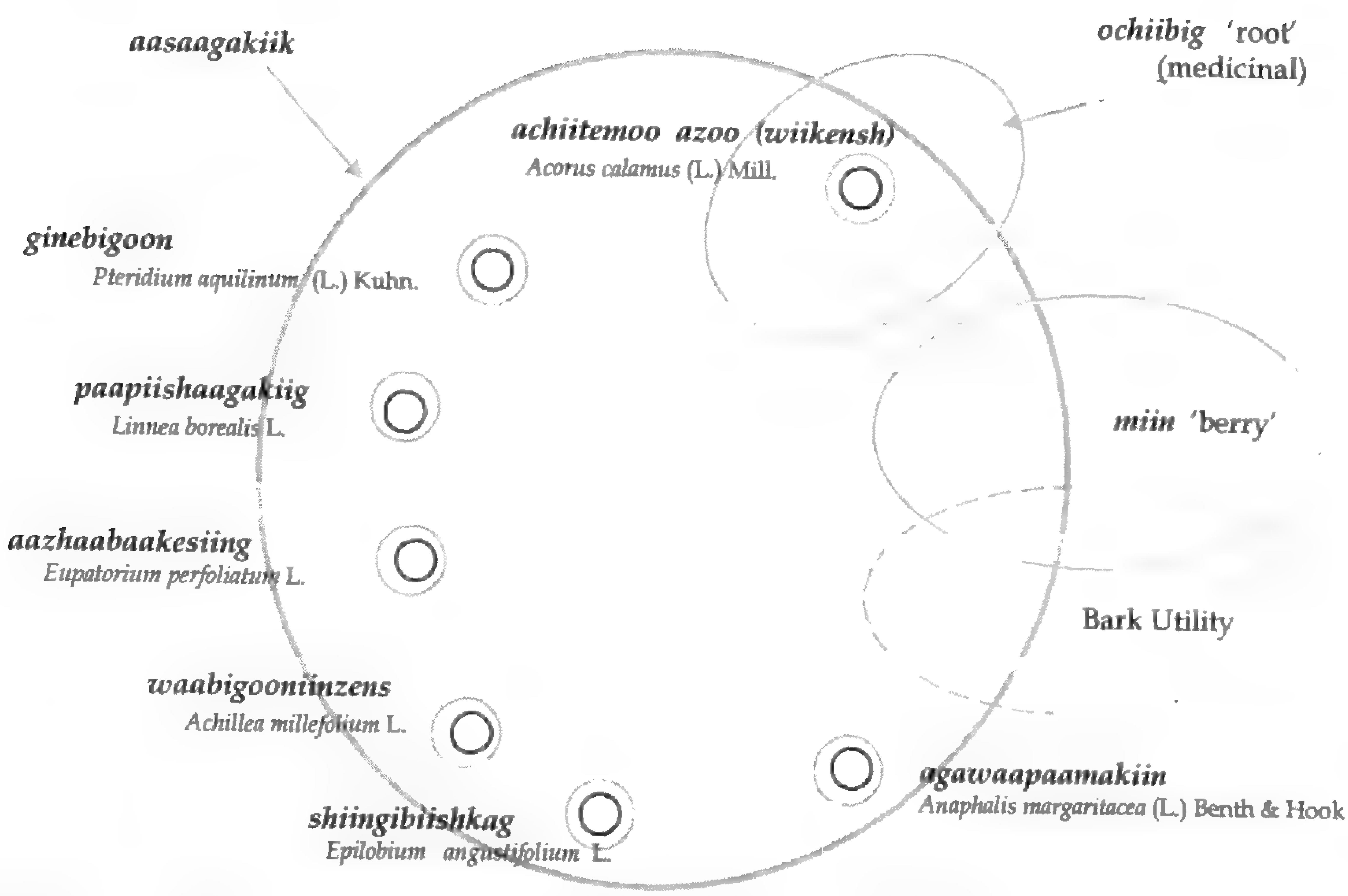

FIGURE 4.—The Lac Seul life form ***aasaagakiik*** s.s. (herbaceous plants, ferns and fern allies) with nested folk generic taxa and overlapping culturally-based groups ***ochiibig*** (medicinal root), ***miin*** (berry) and bark plants (covert).

aasaagakiik *sensu stricto* (s.s., in the narrow sense), to denote only nonwoody herbaceous plants, including ferns, and probably fern allies. The meaning is "things that grow, change and die." Thirteen folk genera were identified within this life form, two of which have synonyms (Figure 4): ***waabigooniinzens*** (*Achillea millefolium*), ***achiitemoo azoo*** (syn. ***wiikensh***; *Acorus calamus* (L.) Mill.), ***agawaapaamakiin*** (*Anaphalis margaritacea*), ***mahkwa ochiibig*** (syn. ***osheysep***; *Apocynum androsaemifolium*), ***waabooz ochiibig*** (*Aralia nudicaulis*), ***osawa ochiibigens*** (*Coptis trifolia*), ***zhaashaagomiinen*** (*Cornus canadensis*), ***shiingibiishkag*** (*Epilobium angustifolium*), ***aazhaabaakesiing*** (*Eupatorium perfoliatum*), ***amiinaadekag*** (*Gaultheria hispidula*), ***paapiishaagakiig*** (*Linnaea borealis*), ***ginebigoon*** (*Pteridium aquilinum*), and ***miin*** (*Vaccinium* spp.). The folk genus ***miin*** contains two binomial folk specifics that correspond to botanical species: ***michaa miin*** (*Vaccinium myrtilloides*) and ***miinens*** (*Vaccinium angustifolium*).

Grasses did not emerge as a separate life form or even folk genus category. Although plants in the flowering stage were presented to the respondents whenever possible, they were included within ***aasaagakiik*** s.l. together with other flowering herbaceous plants.

Two additional groups identified on the basis of cultural utility are contained within ***aasaagakiik*** s.s., and include members of the shrub and nonwoody herbaceous plant groups. The names of these two groups reflect a useful morphological feature or medicinal value (Figure 5). The first of these groups obtains its name from the root word ***miin*** 'berry' and contains seven folk generic names encompassing shrubs and herbaceous taxa listed above. The type is the folk genus ***miin*** (*Vaccinium* spp.) and includes only the 'blueberries'. The folk genera designated by ***miin*** are characterized by their edible berries with only one exception.

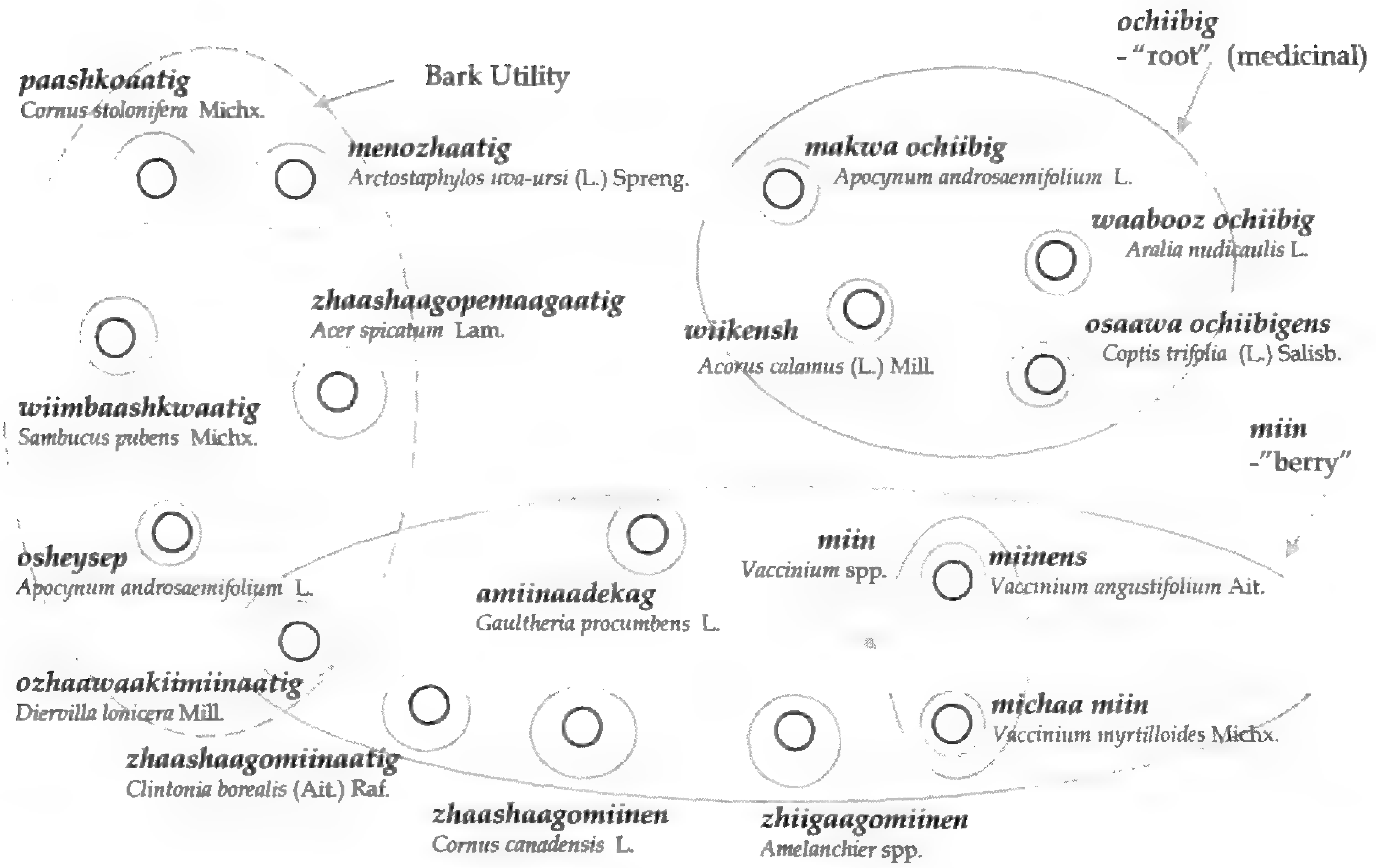

FIGURE 5.—The Lac Seul culturally-based groups ***ochiibig*** (medicinal root), ***miin*** (berry) and 'bark plants' (covert) with nested folk generic and folk specific taxa.

Ozhaawaakiimiinaatig (*Diervilla lonicera*) has oblong seed capsules, which are described by the word ***miin*** 'berry'. At Lac Seul, the word ***miin*** also refers to any tiny, rounded thing.

The name of the second group is derived from the base word ***ochiibig*** 'root' and includes herbaceous plants with medicinal roots, all in the life form ***aasaagakiik*** s.s. (Figure 5). The word 'root' is separate from the modifier (e.g., ***mahkwa ochiibig*** 'bear's root'). These are not food plants; but in the case of ***mahkwa ochiibig*** there is a synonym, ***osheysep*** 'twine', which labels another economic use for the species and refers to the stem of the plant. Medicinal roots are of high cultural significance.

Although neither of the synonyms (***achiitemoo azoo*** and ***wiikensh***) for sweet flag (*Acorus calamus*) contain the base word ***ochiibig***, this taxon is also included in the 'medicinal root' grouping because it is used extensively in medicine and ceremony. ***Wiikensh*** is used by respondents when referring to the ceremonial and medicinal use of *Acorus calamus*. The name ***achiitemoo azoo*** 'squirrel tail' describes the spadix, which was used when our consultants identified fresh or pressed specimens. ***Wiikensh*** may represent an additional folk genus since the term is also applied to *Iris versicolor* L., which has a different medical use.

There are indications of a covert third group 'bark plant' mainly consisting of shrubs having bark used for various purposes. Although there is not a single word for this concept, there are six folk genera names related to the scraping or peeling of the bark to be used for smoking, medicine, and twine making (Figure 6). The Oji-Cree names describe how the bark is harvested or used: ***zhaashaagopemaagaatig*** 'chewing wood' (*Acer spicatum*); ***menozhaatig*** 'healing shrub' (*Arctostaphylos uva-ursi*); ***paashkoaatig*** 'scraping (inner bark) for use' (a synonym for

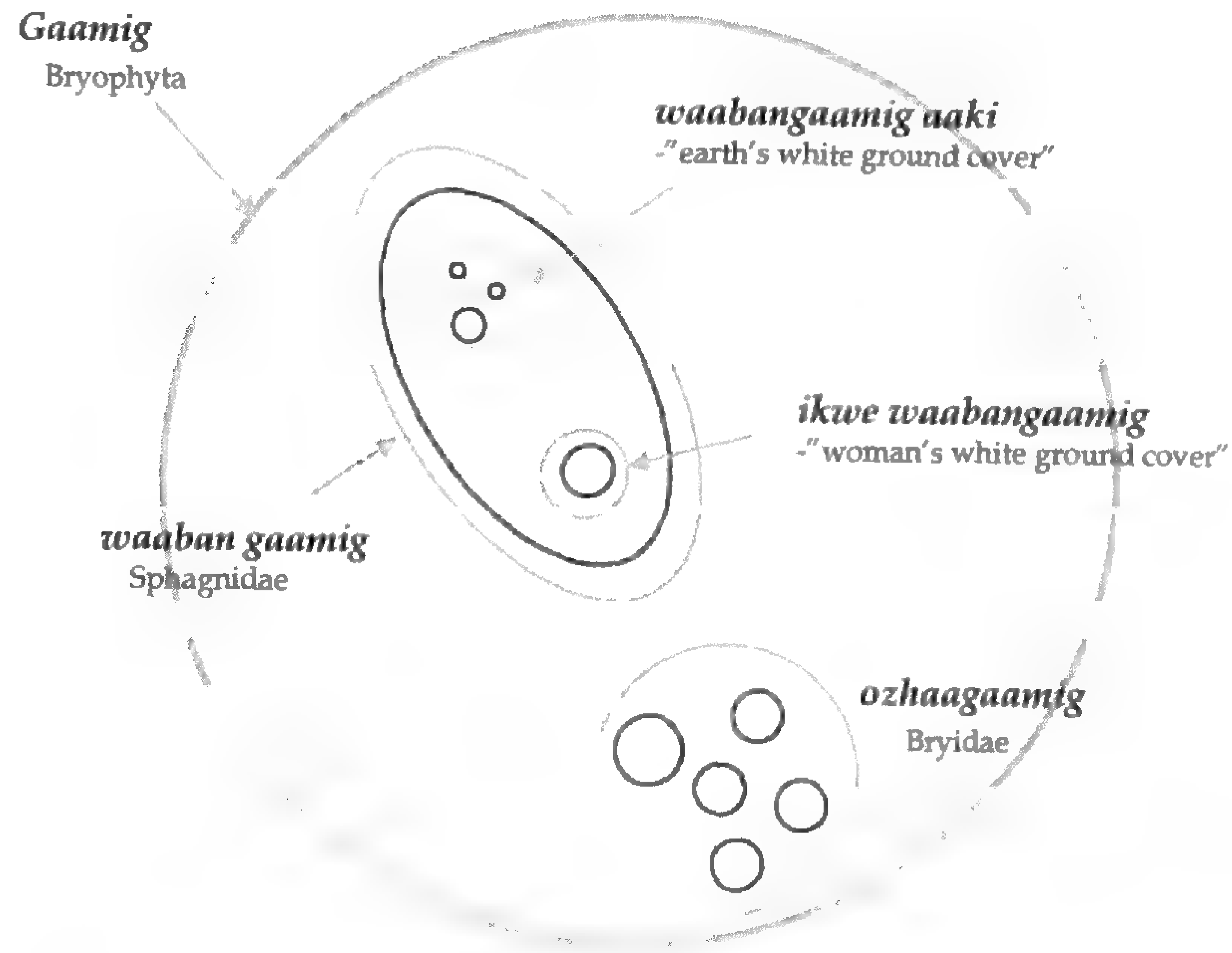

FIGURE 6.—The Lac Seul life form ***gaamig*** (ground cover; 'moss') with nested folk generic and folk specific taxa.

Cornus stolonifera); ***ozhaawaakiimiinaatig*** 'green inner bark shrub with a berry' (*Diervilla lonicera*)—***miin*** is used to identify the capsule of this shrub; and ***wiimbashkwaatig*** 'bursts off the stem (when it is peeled)' (*Sambucus pubens*). The last folk genus, ***osheysep***, is a robust herb (*Apocynum androsaemifolium*) whose name means "twisted for twine." This last folk genus also falls into the ***ochiibig***, or 'root' group, having the synonym ***mahkwa ochiibig***.

The life form ***gaamig*** 'moss' is mutually exclusive of the other life forms. This term means "ground cover" and includes all species of Bryophyta with a spreading unbroken growth pattern (Figure 6). We do not know if the ground lichens are included in this category. The life form ***gaamig*** contains two folk genera, ***waabangaamig*** (Sphagnidae) and ***ozhaagaamig*** (Bryidae). It is not known how many additional genera are recognized in this life-form group, either named or covert. Numerous unidentified *Sphagnum* spp. were grouped together by a respondent as ***waabangaamig*** and include two folk species, ***waabangaamig aaki*** 'earth white ground cover' and ***ikwe waabangaamig*** 'woman white ground cover'. Each of these names are trinomials.

Respondents at Lac Seul identified two additional folk genera, a lichen and a fungus, that could not be categorized under any life form. Unaffiliated genera are usually morphologically different from the genera of other life forms, and Berlin (1992:172–181) describes these as "ambiguous." The arboreal lichen, *Usnea cavernosa* is named ***miishiigan***. This may actually represent a life-form taxon since all *Usnea* spp. were identified as ***miishiigan***, a term which may designate all hanging arboreal lichens. The other unaffiliated genus is ***saagaategan*** (*Inonotus obliquus*), the clinker or cinder polypore conk, which looks like a mass of burned coal (a clinker) stuck on a birch tree. This conk is morphologically discrete from any other life form and even from any other wood decay conks which may also constitute another life form.

Similar Plant Names in Other Ojibway and Cree Dialects.—The Ojibway and Cree languages are part of the larger Algonquian language family which extends from the Atlantic coast of North America across Canada and the United States to Iowa, eastern North Dakota and as far west as Alberta (Ningewance 1993). A comparison of similar plant names in other Ojibway and Cree dialects is shown in Table 3. The eight species shown are ubiquitous in the boreal forest ecosystem where northern Ojibway and Cree reside and in the Great Lakes-Saint Lawrence forest ecosystem where the more southern Ojibway are located. Numerous ethnobotanical researchers working with Ojibway and Cree communities have collected names of plants along with the uses of the species without analyzing the folk taxonomies. Although the researchers used slightly different spelling systems for the Ojibway and Cree dialects, the names of plants show a marked correspondence across widely separated geographical areas.

Aralia nudicaulis (wild sarsaparilla) is named ***waaboozojiibik*** by the Great Lakes Ojibway, ***wabos'odjibik*** by the Ojibway in northern Minnesota and Ontario's Lake of the Woods area, ***waposocipihk*** by the Woods Cree of east-central Saskatchewan and ***waaboozochiibig*** at Lake Seul (Table 3). The consistency of these names covers a distance of several thousand kilometers. The names for *Aralia nudicaulis* are translated as "rabbit's root" in all dialects except the Minnesota/Wisconsin Ojibway (Smith 1932) where the Ojibway word may mean "rabbit woman's medicine." Smith (1932:356) gives the Pillager Ojibway name ***wabo's ûskwe*** and a description of women's use of it as a "remedy for blood purification during pregnancy."

Abies balsamea (balsam fir), is similar in the four Ojibway dialects (Table 3), with overlapping among the names and the synonyms (i.e., ***shingob bigiw, zhingob bigiwaandag,*** and ***aninaandag***). The Lac Seul dialect leaves off the ***-aandag*** suffix used in the three other Ojibway dialects. This ending may correspond to the suffix ***-aatig*** 'woody' which people at Lac Seul use for denoting shrubs. The northern Woods Cree name seems dissimilar but there may be a remnant of similarity in ***napak***.

The names for *Acer spicatum* (mountain maple) were not collected by Densmore (1928) or Leighton (1985); the species is found in Densmore's region of study but not in Leighton's. The names are similar in the three Ojibway dialects. The Lac Seul name includes the 'shrub' suffix ***-aatig***. The differences in spelling are more a feature of variation in orthographic conventions than in actual pronunciation. The suffixes ***-gobiimag*** and ***-gobi'mûk*** are comparable. The "c" in ***caca-*** is pronounced "s" in both the Densmore (1928) and Smith (1932) phonetic pronunciation systems. ***Zshaashaa-*** is pronounced the way it appears.

Betula papyrifera (white birch) was a staple product for manufacturing containers, canoe sheathing, and ***wiigwaamen*** (home or lodge covered with birch bark). The names for white birch are closely related in all dialects. The Ojibway whom Densmore (1928) interviewed included the ***-atig*** suffix 'wood' in their dialect.

Smith's (1932) word, ***ode'imîndji'bîk,*** for *Cornus canadensis* (bunchberry) is the only one significantly different from the others. There may have been some confusion in Smith's data (1932) because he also has *Fragaria virginiana* Duchesne translated as ***ode'imîndji'bîk*** 'heart berry root'. The wild strawberry had a signif-

TABLE 3.—A comparison of plant names in other Ojibway and Cree dialects.

Lac Seul Oji-Cree	Great Lakes Ojibway[1]	Woods Cree Nihithawak[2]	Minnesota/ Wisconsin Ojibway[3]	Minnesota/ NW Ontario Ojibway[4]	Scientific binomial
shingob bigiw	***zhingob bigiwaandag*** syn. ***aninaandag***	***napak a(h)siht***	***jîngo'b pîkewa'ndag***	***a'ninandak'***	*Abies balsamea* (L.) Mill.
zshaashaagopa-maa-gaatig	***zhaashaagobiimag***	n/a	***cacagobi'mûk***	n/a	*Acer spicatum* Lam.
waabooz ochiibig	***waaboozojiibik***	***waposocipihk***	***wabo's ûskwe***	***wabos' odji'bik***	*Aralia nudicaulis* L.
wiigwaas	***wiigwaas***	***waskway***	***wigwas***	***wi'wasa'tig***	*Betula papyrifera* Marsh.
zhaashaagomiinen	***zhaashaagominens***	***sasakominan***	***ode'imîdji'bîk***	***caca'gomin***	*Cornus canadensis* L.
miskaabemig	***miskwaabiimizh***	***miskwapimak***, syn. ***mithkwapimak***	***meskwabi'mic***	***miskwabi'mic***	*Cornus stolonifera* Michx.
bigaanaatig	***bagaanimizh***	***pakan***	***bapa'***	***bagan'***	*Corylus cornuta* Marsh.
azaadii	***azaadii***	***mathamitos***	***manasa'di***	***man'asa'di***	*Populus balsamifera* L.
azaadii	***azaadii***	***mitos***	***asadi***	***asa'di***	*Populus tremuloides* Michx.

[1] Meeker et al. 1993.
[2] Leighton 1985.
[3] Smith 1932.
[4] Densmore 1928.

icant place in southern Ojibway sacred stories, and it seems unlikely informants would have confused it with bunchberry. It could, be a synonym, however (N. Turner, pers. comm.). The other four dialects contain the morpheme ***miin*** or ***min*** 'berry' and probably all translate as "chewable or edible (little) berry."

The names for *Cornus stolonifera* (red osier dogwood) show the closest etymological relationship in this group of plant names. The extraordinarily visible red color of its late-summer bark is marked in the dialects over a wide geographical area. All names include a descriptor for red: ***miska, meskwa, miskwa,*** and the Lac Seul name ***miskaabemig*** 'being red it is visible'. The shrubs are visible in the fall and winter along the lakeshore from a long distance.

Corylus cornuta (beaked hazel) is the only nut-producing shrub in the boreal forest regions where the Ojibway and Cree reside. ***Bigaan***, ***bagaan***, and ***pakan*** all mean "nut"; at Lac Seul the suffix ***-aatig*** 'shrub' is attached to the end of the word. The word "nut" implies food (Europeans adopted the word "pecan"). The names for *Corylus cornuta* refer directly to the nut, but also imply cultural use as food. The last two species, *Populus balsamifera* and *P. tremuloides,* are not differentiated by the Ojibway dialects, both being termed ***azaadii***, ***asadi***, and ***asa'di***; but, the two are different in Woods Cree.

The observed consistency in names of certain plants over a very large geographical area where these groups of people have resided for thousands of years may be the result of three factors. The east-west trade routes brought people together for millennia prior to European contact; these later became part of the fur trade routes. People spoke the same language, if not the same dialect, and would have been able to converse with each other about plants for food and healing. In the boreal forest ecosystem of the north, many of the same species and plant associations are found over large expanses of the region and people would have been able to recognize, talk about, and use the plants in new localities.

DISCUSSION

Northern Ojibway Plant Classification.—This ethnobotanical study is the first research concerning the plant classification system of a northern Oji-Cree speaking community in northwestern Ontario. While this work is only preliminary and does not cover all of the vascular plant species found in the region, the results indicate that a complex, hierarchical folk classification system does exist in the traditional culture and language of the Lac Seul Ojibway.

The plant taxonomic system of the Lac Seul people is based on the traditional perception and use of the ecosystem and mode of subsistence. The Lac Seul Ojibway and Cree lived off their traditional lands and waters in the transition zone between the Boreal and Great Lakes-Saint Lawrence forest ecosystems by harvesting the natural resources, and their plant names exhibit relational comparisons of the plants to animals and landscapes of their environment (e.g., ***ginebigoon*** 'snake place' (bracken fern) and ***miskaabemig*** 'being red it is visible from a distance along shore (implied)' (red osier dogwood).

This study found no name for unique beginner in the kingdom Plantae at Lac Seul, which is typical of most folk taxonomies (Berlin 1992). The rank of covert kingdom Plantae is inferred from a vocabulary of botanical terms (Table 2). Some of this vocabulary is genus specific, meaning that a word will describe the plant part of only one genus, such as ***ozhiigoopiin***, which refers to the boughs of the genus ***zhingwak*** (*Pinus* spp.).

The plant taxonomy at Lac Seul shows a number of features that have been found in the botanical taxonomies of other hunter-gathering people (Hunn 1982; Turner 1973). While the Lac Seul ethnobotanical taxa are intrinsically hierarchical, they do not fit a perfectly hierarchical classification model nor are they mutually exclusive as in scientific botanical classification. Group overlap occurs both between and within ranks.

Subsistence and Folk Species.—Mode of subsistence is an important factor in how groups of people conceptually organize their biophysical world. Most ethnobotanical studies of plant classification have involved horticultural peoples in tropical or subtropical regions of the world (Berlin 1992). The prevailing theory has been that folk species are found primarily in agrarian cultures and only rarely, or in fewer numbers, in foraging or hunter-gathering groups. Foraging people usually average two percent polytypic genera (Berlin 1992:275). The Lac Seul Ojibway are also considered hunter-gatherers and the folk taxonomic data gathered so far, while preliminary, shows nine percent (3 of 34) polytypic folk genera, a value between those of horticulturalists and foragers. Lac Seul Ojibway have a history of manipulating and propagating plants for special uses (e.g., wild rice, blueberries, sweet flag, and certain other medicinal species) and these numbers may reflect that activity. The six identified folk species are all very important in traditional usage at Lac Seul.

Utilitarian-based Taxa in Folk Taxonomies.—Berlin (1992) does not recognize rank based on cultural utility, although he does recognize an intermediate rank based on cultural mythology of utilitarian cultivars in Tzeltal plant taxonomy. Other authors (Hunn 1982; Turner 1973, 1987, 1989; Turner et al. 1990) recognize cultural utility as a rank. Lac Seul botanical taxonomy resembles the systems of other foraging peoples in that taxa apparently have been constituted based on cultural utility. Turner (1973), in her study of the Haida, Bella Coola (Nuxalk) and Lillooet (Stl'atl'imx), Pacific Northwest people, found that the folk taxonomies of these three First Nation groups included 'root' and 'berry' life-form categories although the root category was unnamed. Root plants were either grouped together in discussions about the plant species (i.e., the genus names identify the plants by their roots) or there is a suffix which denotes the root part. In Lac Seul Oji-Cree, the base word ***ochiibig*** is applied to certain herbaceous plants whose roots are medicinal.

In Haida, Bella Coola, and Lillooet, the 'berry' group overlaps with the 'shrub', 'tree', and/or 'herbaceous plant' life forms (Turner 1973). In the Lac Seul system, the 'berry' grouping of plants overlaps with the 'shrub' and 'herbaceous' life forms (Figures 4 and 5). Turner et al. (1990) found that the Thompson (Nlaka' pamux), a Salishan-speaking group in British Columbia, included an economic life form of 'berry/fruit-bearing plants/bushes'. A recent study by Johnson-Gottesfeld and Hargus (1998) with the Witsuwit'en, Athapaskan-speakers in northern British Columbia, also found that life-form taxa may be partly utilitarian and not mutually exclusive.

A final life form with considerable cultural utility is 'moss'. While in many regions recognition of a moss life-form group is unusual (Atran 1985:301), at Lac Seul the mosses are conspicuous as a vegetational entity carpeting the floor of many forest stand types. The life form ***gaamig*** contains two folk genera, ***waabangaamig*** and ***ozhaagaamig***, the former containing two folk species, and both with high utility (Figure 6). While Turner (1973) reported the 'moss' life form was named but empty in the taxonomic system of the First Nation interviewed, Johnson-Gottesfeld and Hargus (1998) found that *Sphagnum* spp. and feather moss are considered ***yin*** 'moss'. The prototype of the life form in this case appears to be *Sphagnum magellanicum* Brid. The Montaignaise people's concept and naming of mosses most closely parallels the situation at Lac Seul. Clément (1990) observed that the suffix -***kamuk***, referring to "plants without roots," terminates the names for various *Sphagnum* spp., caribou lichens, and some feather mosses. The name -***kamuk*** also means "surface" or "crust of the earth," which is comparable to Lac Seul's references to ***waabangaamig*** 'white ground cover'.

SUMMARY AND CONCLUSIONS

There has been no previous research into the folk taxonomic systems of the Oji-Cree and Cree speaking people of northwestern Ontario. The goal of this preliminary study was to record plant names and botanical vocabulary of the Oji-Cree speaking Lac Seul First Nation and determine the method of plant classification. The names of 38 folk genera and folk species were elicited with some synonyms and the words for 18 morphological characteristics, together totaling 65 botanical names or phrases. Although the data set was small, it was apparent that the folk genera correspond to morphologically based life-form categories representing a hierarchical taxonomic system for ordering the plant world.

NOTES

[1] Voucher specimens are in the collection of Mary B. Kenny, Lac Seul First Nation, via Box 317, Hudson, Ontario, Canada.

[2] The pronunciation and spelling of Lac Seul Oji-Cree words and phrases follow the conventions of Ningewance (1993):

Consonants

Pronounced as in English: **m, n, y, h,** and **w.**
Ojibway Consonants: **k, p, ch, t,** and **sh** are similar to English.
g, b, j, d, and **zh** are softer than English.
Aspirated (sometimes) in pronunciation: k (**hk**), p (**hp**), and t (**ht**).
Consonants at the end of a word are voiced: **-iw, -ng, -nd, -nzh, -tw, -dw, -shkw,** etc.

Vowels

Short vowels: (**i**) as in bit
(**o**) as in look
(**a**) as in cup

Long vowels: (**e**) as in red
(**ii**) as in peek
(**aa**) as in 'ah'
(**oo**) as between boot and boat
Nasal vowel endings: **-ens, -aans, -oons, -enz, -iinz, -aanz,** and **-oonz**

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POPULATION TRENDS AND HABITAT CHARACTERISTICS OF SWEETGRASS, *Anthoxanthum nitens*: INTEGRATION OF TRADITIONAL AND SCIENTIFIC ECOLOGICAL KNOWLEDGE

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ABSTRACT.—Sweetgrass (*Anthoxanthum nitens* (Weber) Y. Schouten & Veldkamp) is a valued plant among Native peoples of the northeastern United States and eastern Canada, but Haudenosaunee herbalists and basketweavers have reported declines in its population at traditional gathering sites. We integrate traditional ecological knowledge with field and experimental studies to identify and understand population trends of sweetgrass. The plant's habitat requirements were also investigated; it was found growing under various environmental conditions. We determined that sweetgrass is declining in sites where it was historically present throughout the northeastern United States. In traditional gathering sites, the lack of controlled burning and unsustainable harvesting may be a factor in its decline, but the greatest threats facing sweetgrass throughout the Northeast are economic development and ecological succession.

Key words: sweetgrass, *Anthoxanthum nitens, Hierochloe odorata,* Haudenosaunee, Iroquois, baskets.

RESUMEN.—Este estudio integra conocimiento ecológico tradicional con estudios de campo y experimentales para determinar las tendencias poblacionales del *sweetgrass* (*Anthoxanthum nitens* (Weber) Y. Schouten & Veldkamp) y las causas de estas tendencias. Los herbolarios y tejedores de cestas Haudenosaunee han señalado declives en las poblaciones de *sweetgrass* de los sitios de acopio tradicionales. Se estudiaron los requisitos de hábitat del *sweetgrass;* se encontró en condiciones ambientales variadas, por lo que se considera una especie generalista. Este estudio permitió determinar que además de declinar en los lugares de acopio, las poblaciones de *sweetgrass* también están disminuyendo en localidades donde estaba históricamente presente en todo el noreste de los Estados Unidos. En los lugares de recogida tradicionales, la ausencia de quemas controladas y la recolección insostenible son causas posibles del declive de las poblaciones de *sweetgrass,* pero las mayores amenazas a las que se enfrenta esta hierba en todo el noreste son el desarrollo económico y sucesión ecología.

RÉSUMÉ.—Le foin d'odeur, *Anthoxanthum nitens* (Weber) Y. Schouten & Veldkamp, est une plante fort estimée des Premières Nations du nord-est des États-Unis et de l'est du Canada. Les vanniers et herboristes de la Ligue des Six-Nations (Haudenosaunee) ont mentionné que les populations de cette plante étaient en déclin aux sites traditionnels de récolte. Nous intégrons le savoir écologique traditionnel aux recherches expérimentales et aux travaux de terrain afin de déterminer et de comprendre les tendances démographiques des populations du foin d'odeur. Les paramètres définissant les habitats où se trouve la plante ont été examinés: celle-ci croît sous diverses conditions environnementales. Nous avons pu établir que le foin d'odeur est en déclin dans les sites où il était historiquement présent à travers le nord-est des États-Unis. Quant aux facteurs contribuant au déclin du foin d'odeur parmi les sites traditionnels de récolte, l'absence de brûlages dirigés et la cueillette non durable ressortent comme deux facteurs possibles. Toutefois, le développement économique et la succession écologique forment les plus grandes menaces auxquelles font face les populations de foin d'odeur dans le nord-est des États-Unis.

INTRODUCTION

Anthoxanthum nitens (Weber) Y. Schouten & Veldkamp (=*Hierochloe odorata* (L.) P. Beauv; CNWG), commonly known as sweetgrass, is a perennial grass native to North America that plays a significant role in the lives of the indigenous people who reside within its range. Although sweetgrass is most frequently used as a ceremonial smudge and incense (English 1982; Kavasch and Barr 1999), its predominant use among the Haudenosaunee (also known as Iroquois), is in basketry (Benedict 1983).

Haudenosaunee herbalists and basketweavers interviewed for this study were concerned that sweetgrass populations have diminished and that the plant is now difficult to find in many traditional gathering areas. This observation has also been reported in a publication about the basketmakers of Akwesasne: "While sweetgrass grows naturally at Akwesasne and in surrounding areas, it is becoming more difficult to locate. . ." (Lauersons 1996:31). This study was conducted in partnership with Haudenosaunee basketweavers, herbalists, and ceremonial leaders who are familiar with the ecology and use of sweetgrass. We explore the nature of Haudenosaunee traditional knowledge of sweetgrass, its population trends, and its local and regional distribution. We integrate results from the ethnographic study with an ecological analysis.

Objectives and Hypotheses.—The objectives of this project are twofold. The first objective is to determine if the population of sweetgrass is declining in the northeastern United States and, if so, to explore possible causes of this decline. The second objective is to understand habitat requirements of sweetgrass. Both objectives will be addressed through the integration of Haudenosaunee traditional and scientific ecological knowledge.

While the general distribution of sweetgrass is known (Greene 2000; Lynch and Lupfer 1995), its specific habitat requirements are largely unstudied. Published information concerning the natural habitat of sweetgrass in the northeastern United States is limited. Information indicating sweetgrass's present or historical geographical range, the abundance of sweetgrass in those areas, its population trends, and indigenous management practices associated with the plant is lacking. Traditional knowledge has the potential to enhance the botanical information that does exist.

The hypotheses we tested in this study include: sweetgrass populations are declining throughout the Northeast; development of the landscape poses a significant threat to sweetgrass populations; competition from nonnative plants is a significant threat to sweetgrass populations; sweetgrass abundance is correlated with identifiable environmental variables that characterize its habitat; the Haudenosaunee maintain traditional knowledge of sweetgrass population trends; and the Haudenosaunee maintain traditional knowledge of its local and regional distribution.

Traditional Ecological Knowledge.—Traditional ecological knowledge (TEK) offers a source of biological insight and potential models for conservation biology. It generally encompasses plant geography, plant ecology, and phenology, and often includes information concerning the range and distribution of a species (Kidwell 1973). This knowledge, developed through generations of interactions between native peoples and their lands, can contribute rational and reliable perspectives to the contemporary sciences (Kimmerer 2002; Mauro and Hardison 2000).

The knowledge held by Haudenosaunee practitioners concerning the population trends and habitat requirements of sweetgrass plays a vital role in this project. This knowledge, used in conjunction with a scientific ecological study, contributes to the determination of whether the population of sweetgrass is declining, and assists in understanding its habitat requirements.

METHODS

Ethnographic Methods.—The Haudenosaunee consists of six sovereign indigenous nations, whose populations continue to inhabit New York State: the Seneca, Cayuga, Onondaga, Oneida, Mohawk and Tuscarora (Grassman 1969; Herrick 1995; Lauersons 1996). Although members of all Haudenosaunee Nations produced baskets, it is mainly the Mohawks of the Akwesasne Territory who continue the tradition today (Lauersons 1996). The Akwesasne Territory, or "Land Where the Partridge Drums," is located in the St. Lawrence River Valley near Massena, New York. It is divided by the United States-Canadian border and by the border between the Canadian provinces of Ontario and Quebec (Benedict 1983; Lauersons 1996). It is home to approximately 10,000 Mohawk people, and to the art form of elaborate sweetgrass and black ash basketry (Benedict 1983).

The consultants who contributed to this paper are primarily women who are familiar with and use sweetgrass and who are members of the Onondaga and Mohawk Nations, located in central and northern New York, respectively. Some work for this project has been conducted with basketweavers of the Seneca Nation as well, who reside in western New York.

Eight formal interviews were conducted with Haudenosaunee consultants who are familiar with the ecology of sweetgrass, most are basketmakers, although herbalists and ceremonial leaders were also interviewed. The interviews took place between February and July, 2001: two elder female herbalists from the Onondaga Nation, in their late 60s, four female basketmakers from the Mohawk Nation, with ages ranging from 48–70, a male farmer and ceremonial leader in his 70s, and one female basketmaker from the Seneca Nation, aged 46. All of the consultants are fluent in English.

During the interviews, participants were guided in discussion through a list of topics, but the direction of the interviews followed the participants' train of thought (Huntington 2000). The interview topics focused on whether the participants have noticed a change in the distribution of sweetgrass throughout the region, and if so, which factors they thought were responsible for the change. Past and current harvesting practices and land management through controlled burning were also discussed. In addition, we asked them to share information about areas where they currently gather sweetgrass, and/or traditional gathering sites where sweetgrass is no longer found.

The formal interviews were tape recorded with written permission from the consultant or handwritten notes were taken if the consultant was uncomfortable with being recorded. Each consultant signed a letter of consent and was compensated for his or her time and cooperation.

In addition to the eight formal interviews, nine informal conversations were conducted with Haudenosaunee basketmakers. One of the participants of the informal interviews was a male basketmaker from the Akwesasne Mohawk Territory who was approximately 70 years old. Eight of the participants were women, five of whom were elders ranging in age from 60–80 years, one female from the Seneca Cattaraugus Reservation in her 50s, and two beginning women basketmakers, aged 20, from the Seneca Allegheny Reservation. These conversations were generally short discussions in which a few questions were asked concerning the basketmakers' relationship to and use of sweetgrass, as well as her/his method of harvesting and knowledge of past land management practices involving controlled burning. All of the informal conversations were conducted on the Akwesasne Mohawk Territory in July, 2001.

Participant observation was used in visits to the sweetgrass gathering areas in the vicinity of the Akwesasne Territory. The observations included gathering sweetgrass with three generations of women in the Burns family, and their female friends at their grass collection sites in July of 2000 and July of 2001. This process assisted in our identification of sweetgrass and gave us the opportunity to gain an understanding of the sweetgrass habitat characteristics.

Ecological Field Methods.—Herbarium records enabled us to ascertain the historic distribution of sweetgrass in the Northeast and to obtain information on its habitat preferences. We consulted collections in four major herbaria in the Northeast: the New York State Museum in Albany, Cornell University, the New York Botanical Garden, and Harvard University. In addition, we visited the H. Lee Ferguson Museum Herbarium to obtain information on sweetgrass sites on Fisher's Island, New York. At each herbarium, sweetgrass specimens collected in the northeastern United States were studied and information regarding date of collection, the collection site, associated plants, and environmental conditions of the area were recorded.

This process resulted in over 250 records of sweetgrass throughout the Northeast. Of these, 27 sites were described in sufficient detail to find. The sites were located in: New York (14), Massachusetts (4), Connecticut (2), Vermont (3) and New Hampshire (4). These 27 "sites of record" were each visited to determine sweetgrass presence and to characterize its habitat.

Vegetation at each of the sites of record that was intact (i.e., not lost to development) was studied in order to determine whether sweetgrass was still present at the site and to assess the relative abundance of sweetgrass and associated species. Vegetation presence and cover were quantified by placement of 30 quadrats placed in a stratified random design along three 50-m transects. Each quadrat was a circular plot with a diameter of 0.8 m (approximately 0.5 m^2). The cover of each plant species within each plot was estimated to the nearest 5%. Species were identified following Gleason and Cronquist (1991). All of the 27 sites of record were visited from mid-July to early September, 2000. By sampling in a relatively limited time frame, there was minimal variation in developmental stages of the vegetation.

In addition to vegetation sampling, canopy cover readings were taken and soil samples were analyzed in order to determine if there were significant relationships between sweetgrass abundance and these environmental variables. A Model-A spherical densiometer was used at elbow height to determine the percent canopy cover at three random points at each site. Three soil samples of 7-cm depth were also taken in random points at each site. Each of the soil samples was analyzed for texture and pH in a laboratory at the State University of New York College of Environmental Science and Forestry according to standard methods described by Wilde et al. (1972).

Each site was photographed and a map of the site was drawn showing proximity to water, and the arrangement of the sample plots for future monitoring studies. At the sites where the landscape had been altered through development or succession since sweetgrass was recorded, the vegetation was not formally assessed, but photographs were taken to document the change.

In addition to the 27 sites of record, five Haudenosaunee current and past sweetgrass gathering sites were studied. We identified these sites through participant observation and interviews. The ecological sampling methods used at the sites of record described above were also employed at these gathering sites.

Data Analysis.—The data from the 27 sites of record and the five sweetgrass gathering sites were included in the analysis. In order to determine which plants occurred most frequently with sweetgrass, the average percent cover for every plant species at each site of record was calculated. The total average plant cover was also calculated. Since we were interested only in those plants that might have statistically strong relationships with sweetgrass abundance, those species that had at least 1% cover over all sites and occurred with sweetgrass in at least three sites were included in the data analysis. A Satterthwaite two-sample t-test was performed for each species using SAS (version 7.0) Statistical Program (SAS Institute, Inc. 1990) with the purpose of determining if a relationship exists between these species and sweetgrass abundance. In order to determine if the presence of nonnative species was related to sweetgrass abundance, Satterthwaite two-sample t-tests were performed with the nonnative species collectively, nonnative grasses, and nonnative dicots.

Statistical analyses were then performed on the average percent canopy cover, the percent of sand, silt, and clay in the soil, and the soil pH in order to determine if they were related to sweetgrass abundance. Relationships between sweetgrass abundance and the environmental variables were tested using Pearson's correla-

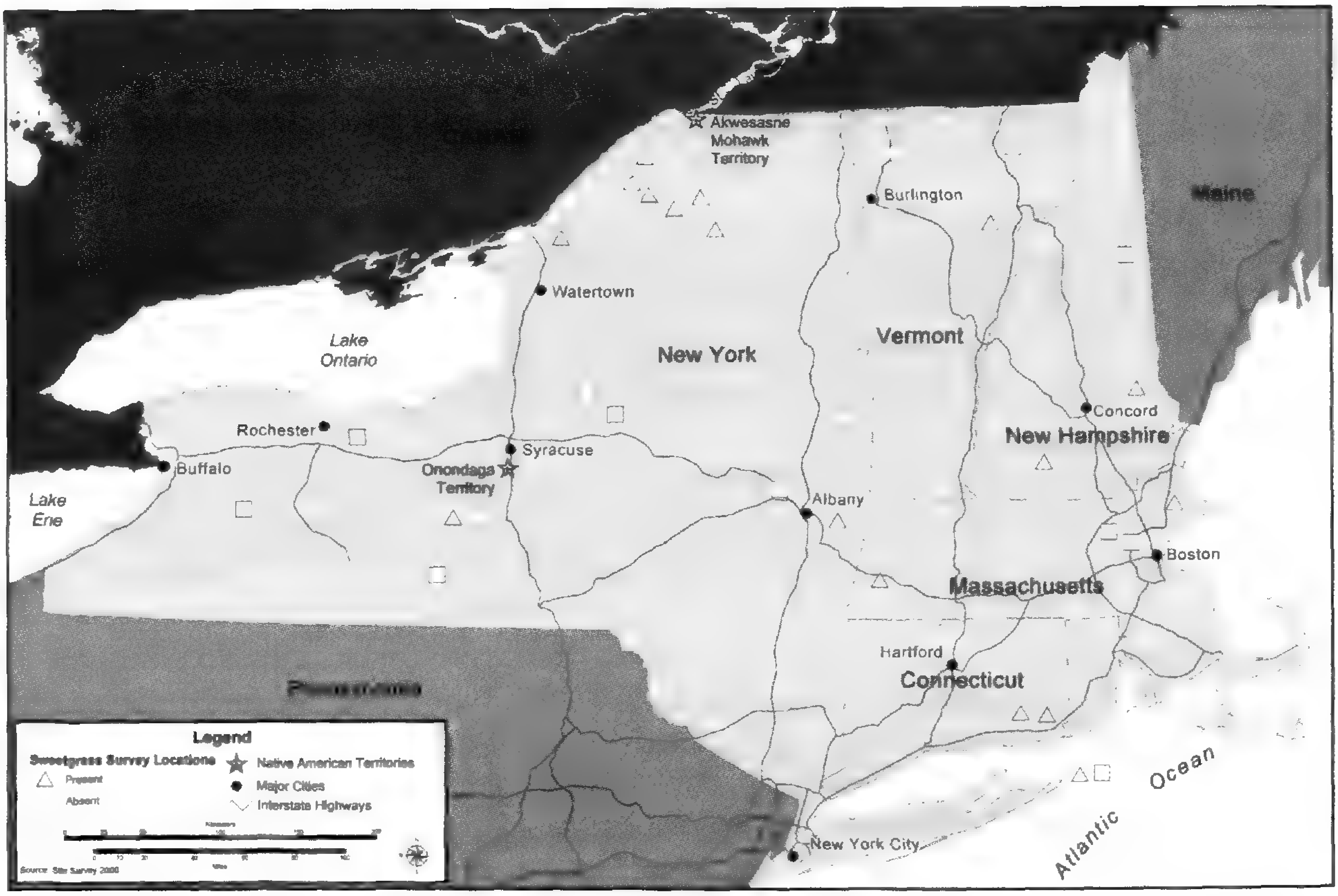

FIGURE 1.—The 32 sites that were visited throughout five northeastern states, five of which are/were Haudenosaunee sweetgrass gathering sites and 27 of which are sweetgrass sites of record.

tion coefficients and coefficients of determinations (R^2) through correlation and regression. These data were analyzed using the SAS (version 7.0) Statistical Program (SAS Institute, Inc. 1990) with sweetgrass percent cover as the dependent variable.

RESULTS

Population Status of Sweetgrass Throughout the Northeastern United States.—Sweetgrass was found at 13 of the 27 sites of record, and 4 of the 5 Haudenosaunee gathering sites. The oldest herbarium record where sweetgrass was still present was taken in 1904 from a tidal marsh in Salem, Massachusetts. In 15 of the 32 visited sites, sweetgrass was not found. The dates of the collection of sweetgrass from these 15 sites ranged from 1913 (Percy, New Hampshire) to 1982 (Wheelock, Vermont). These sites and the probable causes for sweetgrass's absence are illustrated in Figures 1 and 2 respectively.

Population Status of Sweetgrass in Traditional Gathering Sites.—Four of the traditional sweetgrass gathering sites sampled are located within 30 km of the Akwesasne Mohawk Territory, and one is in the vicinity of the Onondaga Nation Territory. In the summer of 2000, sweetgrass was in the four gathering sites located near the Akwesasne Territory: Norfolk, Saint Regis Falls, Dickinson Center, and Hogansburg, New York. Two of these sites, Norfolk and Saint Regis Falls, both are considered to be popular sweetgrass harvesting areas and have a high percentage

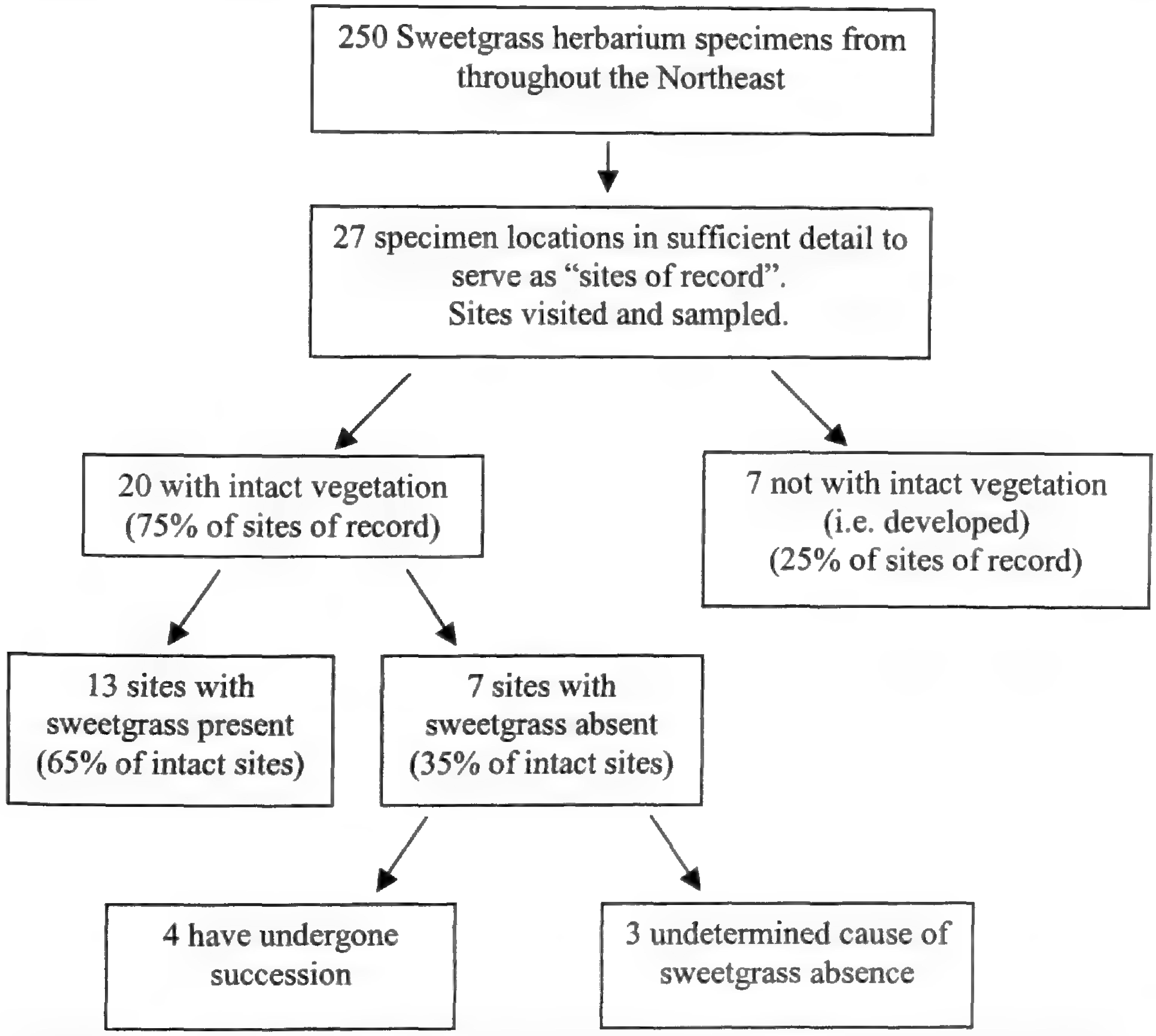

FIGURE 2.—A flow diagram illustrating the number of herbarium specimens studied, the sites of record, the intact and altered sites, the intact sites with sweetgrass present and sweetgrass absent and whether its absence is a result of succession or undetermined causes.

cover of sweetgrass. Dickinson Center, located near the Akwesasne Territory, also has a large amount of sweetgrass. A consultant who harvests sweetgrass from Dickinson Center believes that few people know of and harvest from this site. The remaining site near Akwesasne, in Hogansburg, was once a gathering site, but is no longer visited due to the relatively recent decline of sweetgrass. Sweetgrass was found only in small patches on the Hogansburg site in the summer of 2000.

The other gathering site, LaFayette, is near the Onondaga Nation Territory. In this site, a consultant stated that sweetgrass used to line a creek that runs through the area. She stated that she witnessed the population of sweetgrass slowly declining over the years until approximately 1998 when none remained. Sweetgrass was not found at this site in the summer of 2000.

Habitat Characteristics of Sweetgrass.—The habitats in which sweetgrass was found ranged from wetlands including salt marshes, fens, swamps and marshes to dry roadsides. The variations in values of environmental variables examined for this

TABLE 1.—The location, habitat type, percent sweetgrass cover, percent sand and clay, soil pH, and percent canopy cover of the 13 sites of record and four Haudenosaunee sweetgrass gathering sites where sweetgrass was found in 2000.

State	County	Region	Habitat	% Sweetgrass	% Sand	% Clay	pH	% Canopy
Connecticut	New London	Stonington	salt marsh	3.2	72.7	8.7	5.7	0
Connecticut	New London	Stonington	roadside	0.7	83.5	6.7	5.0	40.8
Massachusetts	Berkshire	N. Egremont	fen	6.8	61.7	8.8	7.6	0
Massachusetts	Essex	Salem	salt marsh	14.3	42.6	11.1	5.5	0
New Hampshire	Cheshire	Stoddard	roadside	18.8	90.0	3.7	5.5	21.6
New Hampshire	Strafford	Dover	marsh	2.5	71.4	8.5	5.0	49.5
New York	Tompkins	Groton	meadow	1.2	52.8	15.7	7.3	0
New York	Rensselaer	Taborton	roadside	4.7	87.1	4.9	7.2	42.3
New York	Essex	N. Elba	riverbank	1.7	94.2	1.9	6.1	9.9
New York	Jefferson	Fargo	roadside	4.3	94.0	2.4	7.3	18.4
New York	St. Lawrence	Potsdam	roadside	2.2	87.8	4.4	7.2	9
New York	Suffolk	Fisher's Island	brackish marsh	1.0	66.2	4.8	6.5	0
New York	Franklin	St. Regis Falls	roadside	6.0	95.5	2.0	7.2	13.1
New York	Franklin	Hogansburg	meadow	0.3	56.5	30.4	7.1	0
New York	Franklin	Norfolk	meadow	15.6	70.9	11.1	6.9	0
New York	Franklin	Dickinson Ctr.	meadow	6.5	85.8	3.7	5.7	0
Vermont	Caledonia	Danville	swamp	7.5	67.2	4.3	6.0	56.5

TABLE 2.—Results of correlation and regression analysis conducted on the environmental variables ($\alpha = 0.05$). The data included in the analysis were collected from the 13 sites of record and four Haudenosaunee sweetgrass gathering sites where sweetgrass was found in 2000.

Environmental variable	Correlation analysis		Regression analysis	
	Correlation coefficient	P-value	R^2	P-value
% Sand	−0.584	0.824	0.177	0.358
% Silt	0.160	0.540	0.177	0.364
% Clay	−0.159	0.542	0.177	0.343
pH	−0.163	0.532	0.177	0.421
Canopy cover	−0.069	0.793	0.177	0.744

study reflect this wide variety of habitats. The pH of the sites ranged from 5.01 to 7.63. There was a wide variation in percent canopy cover over the sweetgrass habitats as well, ranging from 0–56.5%. Sweetgrass was found primarily on sandy soils, however there was a relatively wide variation in the soil texture, from 42.6% sand to 94.2% sand. These environmental data for the 17 sites are presented in Table 1. No significant relationships ($\alpha = 0.05$) were detected between sweetgrass abundance and the environmental variables of soil pH, soil texture and canopy cover (Table 2).

Sweetgrass was found growing among other grasses and shrubs in all of the sites where it was present. It was the dominant species in four of the sites (Taborton, Norfolk, Salem, and Stoddard) but was commonly intermixed with other species and was never found growing in pure stands. A total of 141 plant species, and 110 identified genera were found to occur with sweetgrass in the sample quadrats.

Sixteen species, including sweetgrass, had a cover of at least 1% of the total area surveyed in the 17 sweetgrass sites. These species and their percent cover over the total area sampled are listed in Table 3.

The Satterthwaite t-tests revealed no significant positive relationships ($\alpha = 0.05$) between sweetgrass and co-occurring species. Significant negative relationships were found between abundance of sweetgrass and both wild carrot (*Daucus carota*) and red clover (*Trifolium pratense*) (Table 4).

Wild carrot and red clover are the only two nonnative dicots listed on Table 4. A significant negative relationship was found between sweetgrass abundance and the presence of the nonnative dicots ($\alpha = 0.05$). Sweetgrass abundance was not significantly related to either the abundance of the nonnative grasses (*Phalaris arundinacea, Bromus inermis, Agropyron repens,* and *Phleum pratense* or all nonnative plants (dicots and grasses) included in the data analysis (Table 5).

DISCUSSION

Habitat Requirements and Population Status of Sweetgrass Throughout the Northeastern United States.—The presence of sweetgrass in a wide variety of habitats and the absence of significant relationships between sweetgrass and the environmental variables studied suggest that sweetgrass is a generalist and can thrive in diverse

TABLE 3.—The species present with sweetgrass that had a percent cover of at least 1% of the total sampled area: the 13 sites of record and four Haudenosaunee sweetgrass gathering sites where sweetgrass was found in 2000.

Latin binomial	Common name	Percent cover (total)
Phalaris arundinacea L.*	reed canarygrass	7.35
Spartina patens Aiton	salt-meadow cordgrass	5.83
Anthoxanthum nitens (Weber) Y. Schouten & Veldkamp	sweetgrass	5.72
Solidago candensis L.*	Canada goldenrod	4.06
Agropyron repens L. Nevski*	quackgrass	2.70
Trifolium pratense L.*	red clover	2.86
Phleum pratense L.*	timothy grass	2.42
Vicia cracca L.*	bird vetch	2.01
Poa pratensis L.	Kentucky bluegrass	1.71
Bromus inermis Leyesser*	smooth brome grass	1.62
Panicum clandestinum L.	deertongue	1.27
Daucus carota L.*	wild carrot	1.44
Panicum virgatum L.	switchgrass	1.60
Onoclea sensibilis L.*	sensitive fern	1.44
Asclepias syriaca L.*	common milkweed	1.10
Solidagao sempervirens L.	seaside goldenrod	1.01

Species with an asterisk (*) were found in three or more of the sampled sites and were included in the data analysis for this study.

habitats. In addition to habitat types, the amount of disturbance in areas with sweetgrass also varied. Sweetgrass was found in undeveloped marshes as well as in disturbed areas such as roadsides. There are limitations, however, to the level of disturbance in which sweetgrass can survive. One such limitation is the alteration of the landscape through development.

We hypothesized that sweetgrass populations were declining throughout the Northeast, in part due to habitat loss through development. Our data indicate that only 75% of the sites of record studied were intact; 25% of the sites had been

TABLE 4.—The results of the Satterthwaite t-tests to determine potential relationships between sweetgrass and species present in three or more sites with sweetgrass and constitute 1% or more of the total sampled area (α = 0.05).

	Absent		Present		
Species	Sites	Mean (Std. Err)	Sites	Mean (Std. Err)	P-value
Agropyron repens	12	6.5 (1.8)	5	4.0 (1.1)	0.2678
Asclepias syriaca	14	6.0 (1.6)	3	4.3 (2.0)	0.5205
Bromus inermis	13	6.5 (1.7)	4	3.4 (1.2)	0.1751
Daucus carota	13	6.8 (1.6)	4	2.2 (0.8)	0.0218
Onoclea sensibilis	12	6.0 (1.4)	5	6.0 (3.3)	0.9078
Phalaris arundinacea	14	5.6 (1.4)	3	6.1 (4.8)	0.9259
Phleum pratense	8	6.5 (2.0)	9	5.0 (1.9)	0.6078
Solidagao canadensis	13	6.1 (1.7)	4	4.5 (1.2)	0.4627
Trifolium pratense	11	7.9 (1.7)	6	1.7 (0.7)	0.0051
Vicia cracca	13	5.7 (1.5)	4	5.9 (3.5)	0.9649

TABLE 5.—Results of Satterthwaite t-tests conducted between sweetgrass abundance and the nonnative dicots, nonnative grasses and nonnative plants that were found in at least three sites with sweetgrass and at least 1% of the total area sampled (α = 0.05).

	Absent		Present		
Plants	Sites	Mean (Std. Err)	Sites	Mean (Std. Err)	P-value
Nonnative dicots	11	8.0 (1.7)	5	1.6 (0.6)	0.0045
Nonnative grasses	7	7.6 (2.5)	10	4.4 (1.4)	0.2882
Nonnative plants	5	6.5 (2.3)	12	5.4 (1.7)	0.7121

altered due to development. Habitats were lost due to urbanization, the establishment and maintenance of recreation areas (beaches, parks), and in one case, the reforestation of agricultural land. The findings from this study, therefore, support the hypothesis that development contributes to the loss of sweetgrass populations.

In addition to habitat alteration through development, we predicted that invasion by nonnative plants was associated with decline of sweetgrass populations. Our data indicated no significant relationship between sweetgrass abundance and presence of nonnative species. Despite the presence of exotic species at the majority of the sites, sweetgrass was still found at 65% of the intact sites of record. Of the remaining intact sites, most had undergone natural succession to native forest or shrubland and are therefore no longer suitable for sweetgrass. The persistence of sweetgrass at most of the sites independent of the presence of nonnative plants suggests that sweetgrass is not significantly threatened by nonnative plants. The herbarium records indicated only past presence of sweetgrass, however, not its abundance.

It is possible that the nonnative species do influence the sweetgrass abundance to some extent in the areas sampled. It may not be possible, however, to determine the degree to which the surrounding vegetation is affecting the sweetgrass since the herbarium and oral records did not provide records of sweetgrass abundance in the area at the time of its collection.

Two nonnative species, wild carrot (a biennial) and red clover (a perennial), were found to have a significant negative relationship with sweetgrass. These species are not considered to be invasive (Gleason and Cronquist 1991). Negative relationships found between sweetgrass abundance and the presence of wild carrot and red clover may suggest that there is some competition between them.

There is an alternative explanation to the negative relationship, however, which is more likely the cause for the negative relationships. The co-occurrence of wild carrot and red clover with sweetgrass is due to the similar habitat preferences of the species. Both of the dicots, like sweetgrass, inhabit disturbed areas, such as roadsides, waste places, and fields (Gleason and Cronquist 1991; Newcomb 1977; Reed 1971). The negative association detected likely results from environmental preferences within these habitats. Six out of the seven sites in which sweetgrass was found with at least one of these dicots (Groton, Taborton, Hogansburg, Fargo, Potsdam, and New London) were within five meters of a road. The majority of the quadrats in which wild carrot and/or red clover were found (69%) was in the transect closest to the road; in contrast, most of the quadrats in which sweetgrass was found in these sites were in transects that were not closest to the road (57%). Therefore, the negative association between the presence of wild carrot and red clover and sweetgrass abundance may be due to environmental preferences involving the level of disturbance in the transects, rather than to competition.

Although negative relationships were found only between sweetgrass and wild carrot and red clover, other nonnative species were found with sweetgrass, some of which are considered to be invasive. These invasive plants include smooth brome grass (*Bromus inermis*) and quackgrass (*Agropyron repens*), both perennials that were introduced from Europe and now are commonly found in waste places and roadsides (Gleason and Cronquist 1991; Hitchcock 1935). Sweetgrass's extensive root system and ability to vigorously reproduce vegetatively (Greene 2000) may be responsible for its persistence against these invaders.

The most abundant plant which co-occurred with sweetgrass (7.35% cover) was reed canarygrass, (*Phalaris arundinacea*) a perennial that inhabits marshes, riverbanks, and moist areas (Hitchcock 1935). This species includes native plants as well as commercial genotypes that have European origins. There are no phenotypic differences between the native and European plants. A difference does exist between the two, however. The European genotype of reed canarygrass has a tendency to grow in monoculture and is often considered to be invasive in many natural wetlands in the United States. It grows vigorously and is able to inhibit and eliminate native species (White et al. 1993). The fact that a negative relationship was not found between reed canarygrass and sweetgrass may indicate that the plants found growing with sweetgrass are of the native genotype.

Sweetgrass was found in only 48% of the sites of record. This finding indicates that the northeastern sweetgrass population is indeed declining in sites where it was historically present. The population trends that were examined in this study are limited by information that was gathered in the past on sweetgrass habitat. Trends in sweetgrass populations throughout the Northeast were determined by its presence or absence in areas that were previously recorded as sweetgrass habitat. It is possible that although sweetgrass was absent from some sites where it was historically present, the species is colonizing other areas. The lack of information about areas where sweetgrass was absent in the past, however, makes this determination impossible.

Ethnographic Findings.—Participatory research is a method of study that provides cross-cultural opportunities for cooperation and communication (Colorado 1988). Participatory observation in this study was important to establish a rapport with the sweetgrass gatherers. Sweetgrass is primarily used by women in basketry, and men do not often gather the grass (Lauersons 1996). Many Haudenosaunee women have shared the harvesting of sweetgrass with family members and friends for countless generations. As Christine Horn, a sweetgrass gatherer in her sixties recalls: "We'd go out, the females in my family. We'd pick berries in June, and sweetgrass in July. It was a way of life at the time, this is what you did."[1]

We were taught to recognize sweetgrass by its distinct shiny, light green blades and purple base. To confirm its identification, Theresa Burns told us to crush some of the blade to release the sweet fragrance. One of the women with whom harvesting was conducted was colorblind and had no sense of smell, and still recognized sweetgrass by its shine. Theresa Burns instructed us to harvest the sweetgrass by pinching the base of the stem, just above the ground, so as not to disturb the root. Each blade of sweetgrass is picked individually, while taking care not to bend or damage the blade. The act of "cleaning" involves the removal of any brown, dried, or broken blades and keeping the long, bright green grass (Lauersons 1996 and Shebitz, personal observation).

Meeting with and interviewing individuals who each have their own use and understanding of sweetgrass contributed various perspectives on the importance of the plant to Haudenosaunee culture and to the environment. When asked to describe the link between sweetgrass and the Mohawk culture, Christine Horn stated: "It can't be separated, it's just being Indian."[2]

All of the individuals who took part in the formal interviews and most of the informal interviewees (five out of six) were concerned that sweetgrass populations are declining in the vicinity of their reservations. When asked about the status of sweetgrass in a formal interview, a Mohawk basketweaver who preferred to remain anonymous stated: "I can't find it anymore, it's difficult to find. It's become evasive. When going to pick it on the Rez, my old favorite spots don't have sweetgrass anymore."[3]

Both the formal and informal interviews revealed the Seneca basketmakers' beliefs that although sweetgrass was abundant in western New York in past centuries, it is now rare, if present at all, in the area. Michele Dean Stock is one of the only Seneca basketmakers remaining. She believes that the absence of sweetgrass and black ash in the area is partly responsible for the fact that traditional Seneca baskets are currently seldom made:

> To my understanding, there was a time when you can gather sweetgrass on the reservation in certain spots . . . there was a time when it was at Allegheny Reservation but it's been at least 100 years that people haven't been able to find it there.[4]

When asked why they believed that sweetgrass populations were declining, five of the eight participants in the formal interviews stated that they felt that sweetgrass is threatened by nonnative plants. As Onondaga herbalist Otatdodah Homer stated, "I blame the invaders . . . Foreign plants from other areas."[5] In particular, four of these participants specifically referred to purple loosestrife, *Lythrum salicaria* L. Purple loosestrife was found in small quantities at the two harvesting sites, Akwesasne and LaFayette, which were reported by interviewees to be past harvesting areas of sweetgrass. It was not found at any of the other 30 sites visited.

Ecological disturbance is one factor that might be responsible for the absence of sweetgrass in LaFayette, which is now a popular park. Also, the interviewee who gathered from this site believes the water in the creek to be polluted. The meadow in Hogansburg (Akwesasne) has been a popular sweetgrass gathering site for the past 50 years. The decline of sweetgrass in the Akwesasne area led me to inquire about the past land management practices in the vicinity of both the Akwesasne and Onondaga territories.

Traditional knowledge systems provide insights on the management of resources and ecosystems (Berkes et al. 2000). One of the goals of the interviews was to gain an understanding of past land management and sweetgrass harvesting practices. This topic was covered to determine if a change in these practices might be the cause of the reported decline in sweetgrass populations in the vicinity of the Akwesasne Reservation and other harvesting areas.

It is possible that sweetgrass is not found on the Akwesasne meadow because of the manner in which it was harvested. Sweetgrass reproduces primarily by its rhizomes (Green 2000; Winslow 2000). To many, sweetgrass is traditionally harvested by grasping the shoots firmly at the base of the stem and pinching or pulling them until they break loose from the rhizomes and roots, which are an inch or two below the surface (English 1982). Theresa Burns explained that:

> The way I pick sweetgrass is the same way that my grandmother picks sweetgrass. She never takes the root, so that it can come back next year. As she's picking, she cleans it. I don't get as much sweetgrass as maybe somebody else does because I like to get it all clean, I don't like to clean it when I get home . . . that's the way she does it, she cleans as she goes. And she's very selective as she picks, and I am too.[6]

Not all Haudenosaunee sweetgrass gatherers, however, practice this method of harvesting. Knowledge bases, whether they are western scientific or traditional are both collective and individual in nature. As such, they reflect a diversity of perspectives. All seventeen of the consultants in both the formal and informal interviews reported that some Native gatherers are now taking the roots when they harvest the sweetgrass. Eight stated that they harvest sweetgrass from its root and do not believe that this method affects the sweetgrass population. Thomas Porter, a Mohawk leader who burns sweetgrass as an incense in ceremonies, stated in a formal interview that ". . . we take the whole plant, just pull it up, and some root comes off too, but that's not a problem, it doesn't hurt the grass."[7]

Onondaga herbalist Jeanne Shenandoah explained the lesson she received from her friend when they went out to pick sweetgrass:

> She said "Oh you have to take the roots up when you pick it." She'd have big bunches of it with the roots. She said if you don't pull the roots up, it won't stay green. And I thought, you would hope that people would be considerate so as not to take the whole patch, you know? So that it could multiply. I was really shocked when she said "Pull the roots."[8]

By pulling the entire plant and removing the roots and rhizomes from the ground, that plant's energy storage and primary reproductive means is lost. Whether this action negatively affects the overall sweetgrass population is debatable. There are documented cases where indigenous harvesting practices that involved the digging of subterranean organs of wild plants, such as rhizomes, in fact benefited the overall population of the plant. For example, M. Kat Anderson (1997:149) presents the argument that tillage activities practiced by Native Americans of California ". . . mimicked natural disturbances with which the plants coevolved, and played an ecological role that is now vacant in many wildlands, where Native Americans can no longer harvest and manage plants."

Five interviewees (three from the Burns family) stated that they were taught from their mothers and grandmothers to cut the sweetgrass at the base of the stem, so as not to disturb the root, and that this method was used by their ancestors. All of these participants are angered when they see people, both Native and non-Native, harvesting sweetgrass from its root and believe that only recently have people begun, in their haste, to carelessly pull the roots of sweetgrass. Otatdodah Homer stated, "I think people pick it and they didn't know how to pick it. They would just pull it up from the root. And by pulling it up from the root, there goes the plant! . . . Obviously they're not properly picking."[9]

Another issue which was brought up in four of the eight formal interviews was the possibility that sweetgrass is being overharvested. The removal of the roots and rhizomes, in conjunction with overharvesting, possibly affects the sweetgrass population of Akwesasne. The Haudenosaunee Environmental Task Force warns that overharvesting particular plant species is a threat that faces the native grasses of Akwesasne. This unsustainable harvesting may eliminate whole generations of new plants as people tend to pick the strongest of plants, leaving the young and frail ones to continue to the next generation. Arquette (2000:57) comments, "Every plant has a leader among their family group. When we target the leader and discard the others, we weaken the entire remaining family group." Efforts are being made by the Task Force to educate individuals about the importance of harvesting sweetgrass sustainably. With the cooperation of the Task Force, Arquette (1999) has written an information pamphlet on preserving and restoring small plants and sweetgrass that instructs gatherers of sweetgrass to pick it sustainably, to not overharvest, and to replant roots from sweetgrass that are picked.

In addition to unsustainable harvesting of sweetgrass, the absence of controlled burning might be responsible for the decline in sweetgrass populations. Many indigenous societies create small-scale disturbances, such as fire, to "nurture sources of ecosystem renewal" (Berkes et al. 2000:1256). Fire is a significant ecological factor in maintaining perennial grasses in grassland ecosystems (Anderson 1996). Fires set by indigenous people were often used to increase yields, recycle nutrients, clear detritus, and promote growth of desired plants in the midst of reduced competition (Anderson 1996). Since some plants used in basketry require burning, the absence of controlled burning, and modern fire suppression policies have created difficulties for contemporary weavers (Ortiz 1993).

All of the consultants for this study stated that they recall land being burned by their grandparents, mostly for the regeneration of hay. In fact, two of the interviewees remember that the fields from which they used to harvest sweetgrass were burned for hay until approximately 50 years ago. Theresa Burns recalled that:

> Most of the time what they burned for was hay. So that the hay would come in, they'd always burn it. In the spring, right after the snow went away. . . . [S]uch a great smell, the burning. I used to walk through [the fields] and just get all full of the grass smoke, it was great. They did that because . . . burning puts all the nutrients back in the soil.[10]

The increased abundance of sweetgrass in these areas was probably not the aim of the burning, but a result of it nevertheless. Two individuals who took part in informal interviews, both of whom were elders from the Akwesasne territory, stated that burning has been done specifically to encourage sweetgrass growth. The consultants of both informal and formal interviews explained that although some controlled burning is still carried out, the practice has become much less common over the course of the past 50 years. When we inquired why burning was not practiced often, the consultants responded that now people are too concerned about burning their neighbor's homes, there is not a great deal of space left. Thomas Porter explained, "Growing up in Akwesasne, I used to help my family burn our land, and the land around our area... It's hard to control fire. When wind blows, it could burn the homes and the whole forest."[11]

At each interview, we expected to hear that the consultant thought that the absence of controlled burning might be responsible for the decline of sweetgrass in traditional gathering areas. This possibility was not brought up in any of the interviews, however, until we explained our theory. The tolerance of sweetgrass to fire (Walsh 1994) was discussed with each consultant. Since fire does not consume the underground rhizomes, the grass can recover from burning, while benefiting from the increased sunlight and nutrient availability (Lynch and Lupfer 1995). The rhizomes of sweetgrass often sprout after aerial portions are burned and culms arise from among the dead foliage of the preceding year (Walsh 1994). It is possible that the foliage protects basal buds from fire damage in the spring, when the dead foliage is rich in moisture (Walsh 1994). After our perspective was explained, the interviewees agreed that the lack of controlled burning in the vicinity of their nation's territory might be responsible for its current absence in past gathering sites.

Through the interviews, the strength of the connection between the Haudenosaunee people and sweetgrass was made apparent, as was their concern for the fate of sweetgrass. Otatdodah Homer explained there is a fear "... that it's becoming extinct... It's important to our culture and we want to keep it alive, to keep using it... I think that scientists should know that it's sacred to us native peoples..."[12]

CONCLUSION

Berkes et al. (2000:1521) stated, "Indigenous groups offer alternative knowledge and perspectives based on their own locally developed practices of resource use." This understanding was central to the research presented in this study. The knowledge possessed by the Haudenosaunee proved to be valuable in identifying population trends and in characterizing sweetgrass ecology and habitat. Detailed knowledge of past and present harvesting techniques and land management practices, such as controlled burning, contributed to understanding of the influences that may be responsible for the difficulties in locating sweetgrass in traditional gathering areas.

Most of the threats that face sweetgrass populations throughout the Northeast are no different than the threats that face other midsuccessional species that inhabit moist areas. Habitat destruction brought about through the draining of wetlands, suppression of natural fires, lack of controlled burning, and ecological succession, has led to the replacement of sweetgrass habitat with altered landscapes.

These threats are a result of shifts in cultural practices; as the Haudenosaunee have changed their traditional land management practices and urbanization encroaches upon what remains of the undeveloped landscape.

The integration of knowledge bases in this study allowed us to frame and approach the questions concerning ecological requirements and population trends of sweetgrass. Approaching this project from both an ecological and ethnographic perspective enhanced the understanding of sweetgrass for this study, and may prove to be beneficial in future sweetgrass conservation efforts. On the Onondaga and Akwesasne territories, a return to traditional land management practices such as controlled burning and sustainable harvesting practices may be the primary means to ensure that sweetgrass populations persist. The continued presence of sweetgrass in the vicinity of the territories will enable traditions associated with the plant to endure.

NOTES

[1] Christine Horn, interview, July 12, 2001.

[2] See note 1.

[3] Anonymous interview, February 15, 2001.

[4] Michele Dean Stock, Seneca basketmaker, interview, July 10, 2001.

[5] Otatdodah Homer, Onondaga herbalist, interview, February 15, 2001.

[6] Theresa Burns, interview, February 15, 2001.

[7] Thomas Porter, a Mohawk leader, interview, May 30, 2001.

[8] Jeanne Shenandoah, Onondaga herbalist, interview, April 25, 2001.

[9] See note 5.

[10] See note 6.

[11] See note 7.

[12] See note 5.

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STRUCTURE, PHENOLOGY, FRUIT YIELD, AND FUTURE PROSPECTS OF SOME PROMINENT WILD EDIBLE PLANT SPECIES OF THE SIKKIM HIMALAYA, INDIA

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ABSTRACT.—In the Himalaya a large variety of plants that grow in forest areas are used as food, and a few of them are exploited on large scale. We discuss six wild tree species of the Sikkim Himalaya that yield edible fruit and that are of great economic value to rural people: *Baccaurea sapida* (Roxb.) Muell.-Arg., *Diploknema butyracea* (Roxb.) Lam., *Elaeagnus latifolia* L., *Eriolobus indica* Schn., *Machilus edulis* King, and *Spondias axillaris* Roxb. These species, which are an important component of forest diversity, are found in low densities, have poor rates of regeneration, and suffer from overexploitation by the local population. All the species have market value and significant potential for value addition. The per-tree fruit yield was fair for each species, and plantation stands could generate high economic returns. It is suggested that a large-scale propagation plan is needed for these species so that farmers could cultivate them, which would reduce the pressure on the wild populations of the forests.

Key words: wild edible plants, structure, regeneration, phenology, fruit yield, marketing.

RESUMEN.—En el Himalaya Sikkim se utilizan como alimento una gran variedad de plantas que crecen en las áreas boscosas, y pocas de ellas se explotan a gran escala. Examinamos seis especies arbóreas silvestres de la región que producen frutas comestibles y que son de gran valor económico para las gentes rurales: *Baccaurea sapida* (Roxb.) Muell.-Arg., *Diploknema butyracea* (Roxb.) Lam., *Elaeagnus latifolia* L., *Eriolobus indica* Schn., *Machilus edulis* King, y *Spondias axillaris* Roxb. Estas especies, que constituyen un componente importante de la diversidad forestal, aparecen en densidades bajas, tienen bajos índices de regeneración, y sufren de sobreexplotación por la gente local. Todas las especies tienen valor en el mercado y un potencial de valor añadido significativo. La producción por árbol es bastante abundante para cada especie, y una plantación podría generar altos beneficios económicos. Sugerimos que se necesita un plan de propagación a gran escala para estas especies de forma que los granjeros pudieran cultivarlas, lo que reduciría la presión sobre las poblaciones silvestres de los bosques.

RÉSUMÉ.—Dans le Sikkim himalayen, une grande diversité de plantes, poussant dans les milieux forestiers, sont utilisées comme plantes alimentaires. Plusieurs sont exploitées à grande échelle. Nous discutons de six espèces d'arbres indigènes de cette région qui donnent des fruits comestibles, soit *Baccaurea sapida* (Roxb.) Muell.-Arg., *Diploknema butyracea* (Roxb.) Lam., *Elaeagnus latifolia* L., *Eriolobus indica* Schn., *Machilus edulis* King et *Spondias axillaris* Roxb. Ce sont des espèces dont la valeur économique est importante pour les populations rurales. Ces espèces forment une part importante de la diversité forestière. Elles se retrouvent à faible densité, possèdent un taux de régénération faible et sont surexploitées par la population locale. Toutes les espèces possèdent une valeur commerciale et un grand potentiel pouvant augmenter leur valeur. Le rendement des récoltes de fruits par arbre était assez bon pour chacune des espèces. Aussi, les plantations pourraient générer un grand profit économique. Aussi, un plan de propagation est nécessaire afin que les agriculteurs puissent cultiver ces espèces. Cela réduirait la pression exercée sur les populations naturelles que l'on trouve en forêt.

INTRODUCTION

People throughout the tropics depend on their indigenous plants for food security and a multitude of everyday products from medicines to fibers. Large numbers of plants are collected from forests and other wild areas to meet subsistence food needs of the people (Arora and Pandey 1996). Such dependence is even greater in the Himalayan region (Samant and Dhar 1997). Wild species producing edible products could play a prominent role in increasing the income of farm households if cultivated or harvested sustainably (Phillips 1993). Some of these plants are rich in nutrients, and their consumption helps to maintain a balanced diet among the rural population (Sundriyal and Sundriyal 2001a). Therefore more attention should be paid to the natural associations, fruit yield and regeneration of potential wild edible species, as many of them often function as keystone species and provide food not only to people, but to many frugivores as well.

In the Sikkim Himalaya, 190 wild plant species used by local communities for food have been screened (Sundriyal 1999; Sundriyal et al. 1998). All of them are collected from wild habitats and to date no effort has been made to cultivate them. We discuss the structure, regeneration, phenology, fruit yield, and marketing of the six most widely used wild plants of the Sikkim Himalaya that produce edible fruits. Due to their poor regeneration in forest habitats, there is an urgent need for them to be propagated under nursery conditions. The study highlights the condition of these species in the forests of Sikkim and provides related information that will be useful for their management.

MATERIALS AND METHODS

The Sikkim Himalaya is the part of Eastern Himalaya, with an elevational range of 300 to 8579 m above msl. Sikkim State has a total area of 7096 km^2, which is just 0.02% of the total area of India. It has a population of 505,505, of which 85% lives in villages. The region is rich in cultural and biological diversity. Lepchas, Bhutias, Limbus, and Nepalese are the main ethnic groups; Nepalese are most numerous. Farmers practice double cropping in the valleys and single cropping at higher elevations (Sundriyal et al. 1994a). In Sikkim, 36% of the area is forested, 15% is under cultivation, 10% is pasture and 25% is barren land. The state has subtropical, temperate and subalpine forests as one goes from lower to higher elevations (Rai and Sundriyal 1997; Sundriyal et al. 1994b, Sundriyal and Sharma 1996). All the forests provide diverse products, such as timber, firewood, fodder and NTFPs (non-timber forest products). Plants with edible parts are found growing in all the forest stands, are very popular among local people, and a large variety is also brought to markets.

The climate of the area is typically monsoonal. Due to its proximity to the Bay of Bengal, it has high rainfall and humidity, which supports the growth of luxuriant vegetation. Average annual rainfall varies from 1200 mm (at 300 m elevation) to 4500 mm (at 2000 m elevation), and over 80% of the rain comes during the monsoon season (June through September). The average maximum temperature varies from 21° to 35°C while the average minimum temperature varies from 12° to 23°C. The winter (December through February) is generally rainless and cold. The minimum temperature during this period varies from 0°C at higher elevations to 9°C in the valleys, while maximum temperature ranges between 13° to 28°C. October to November is the autumn period; spring falls in March and April. Pleasant weather prevails during these two seasons.

The legal status of forests may be categorized into Reserve Forest (legally protected areas), Khasmahal Forest (forest area designated for the use of villages for meeting their fuel and fodder needs), Community Forest (owned by a village) and Private Forest (owned by an individual farmer). The Sikkim Forest Department manages Reserve and Khasmahal forests and village community or individual farm family manage Community and Private forests.

Description of Selected Wild Edible Plants.—For the present study species were selected with regard to their potential in terms of their importance to local population; high anthropogenic pressure in the natural habitats; high local demand for the fruits; market value; dearth of information available about their structure, phenology, regeneration and growth; and the possibility of incorporating the propagation of these species in traditional agroforestry systems. Six wild edible species met these criteria and were selected for detailed study: *Baccaurea sapida* (Roxb.) Muell.-Arg., *Diploknema butyracea* (Roxb.) Lam., *Elaeagnus latifolia* L., *Eriolobus indica* Schn., *Machilus edulis* King, and *Spondias axillaris* Roxb. All are trees except *Elaeagnus latifolia,* which is a liana (woody climber).

Baccaurea sapida (syn. *B. ramiflora* Lour., Euphorbiaceae; local name: *kusum* 'sapida') is a small to medium size (up to 10 m height) semi-evergreen tree that grows in the subtropical forests at elevations of 500–1500 m above msl. The yellowish fruits are available from May to August.

Diploknema butyracea (syn. *Bassia butyracea* Roxb., *Aesandra butyracea* (Roxb.) Baehni, Sapotaceae; local name: *chiuree* 'Indian butter tree') is a tree of nearly 15 m height, that grows at elevations of 300–1300 m above msl. The fruits are scented and pulp is juicy and sweet.

Elaeagnus latifolia (syn. *Elaeagnus conferta* Roxb., Elaeagnaceae; local name: *muslendi* 'bastard oleaster') is a large evergreen liana that grows at lower elevations in the Sikkim Himalaya. Fruits are collected during March and April and are commonly available in the markets at that time.

Eriolobus indica (Rosaceae; local name: *mehal* 'Indian crabapple') is a deciduous tree (9–12 m height) of the lower temperate zone (900–1800 m above msl). Fruits are available July–September and eaten fresh or processed into a form of pickle.

An extract of the fruit is made into *chuk,* a medicine valued for relieving stomach pain.

Machilus edulis (syn. *Persea fructifera* Kost., Lauraceae; local name: *pumsi*) is an evergreen tree of about 20–30 m height that grows in natural forests at elevations above 1700 m. It is considered to be a local variety of avocado (*Persea americana*). Fruits are commonly found in markets during December to March, and the outer fleshy pulp that comes out attached with the skin is scooped out and eaten.

Spondias axillaris (syn. *S. acuminata* (L.f.) Kurz., *Choerospondias axillaris* (Roxb.) Burtt. & Hill, Anacardiaceae; local name: *lapsi* 'hog-plum') is a tree that can reach a height of 35 m. It commonly grows in lower hill forests. The ripened fruits are eaten raw. The fruits that are sold at a semiripe stage are pickled, which gives them a shelf life of up to 3–5 years.

METHODS

Vegetation Structure Analysis and Regeneration.—In order to analyze the vegetation structure and regeneration for the six selected species, eight forests were chosen for detailed study based on the preliminary surveys done for areas that are frequented by forest dwellers. The vegetation was sampled with 10 × 10-m quadrats. Depending upon the area of each of the forests, between 30 and 40 quadrats were examined (Sundriyal 1999). All tree species and indviduals growing in a quadrat were listed and their cbh (circumference at breast height) was noted. Woody plants with >32.4-cm cbh were counted as trees (Sundriyal et al. 1994b; Sundriyal and Sharma 1996). The frequency, density, abundance, and basal cover (ground area covered by each species) were calculated following the method given by Curtis and Cottam (1956). To measure the dominance of each tree species, the Importance Value Index (IVI) was calculated as a sum of relative frequency, relative density and relative dominance (Mueller-Dombois and Ellenberg 1974). For each stand, the species with the highest IVI was considered most dominant. The A/F (abundance/frequency) ratio was calculated to interpret the distribution pattern of the species; a value <0.025 shows regular distribution, between 0.025–0.05 shows random distribution, and >0.05 shows contagious distribution of the species in the forest stand (Saxena and Singh 1982).

The regeneration of all species was assessed from 20 randomly selected quadrats of 10 × 10-m size in each forest stand. All plants with <32.4-cm cbh consisting of saplings and seedlings of woody species were considered to be regenerating individuals (Sundriyal et al. 1994b; Sundriyal and Sharma 1996), and density for all species was noted that also included wild edible plants in each stand.

Phenological Investigation.—Study of the phenological stages of a species provides information on its functional aspects: growth of buds, leaf fall and leafing out, anthesis, fruiting and seed dispersal in relation to months, season or years that describes seasonal aspects of ecological phenomenon. Understanding phenology is very important for optimal species management under forest conditions. The phenological investigation for each species was conducted in at least two stands. For each species, 5–8 individual trees were marked at each stand to study the phenological observations on leaf fall, leaf bud formation and flushing, flower bud formation and anthesis, fruit formation and maturation, and seed dispersal (Ralhan et al. 1985; Sundriyal 1990).

Fruit Yield.—Fruit yields were determined by harvesting and recorded individually by tree. For all the species, individuals of different girth classes and heights were marked at different locations well before fruit bearing. Tree girth at breast height, and height (with the help of a bamboo stick) was measured for all selected individuals. Efforts were made to harvest almost all the fruits of small trees. For big trees it was not possible to harvest all the fruits. Therefore, the uncollected fruits were counted visually and converted to biomass value based on the harvested fruits. This method accounts for nearly 70–80% of total fruit yield. Per-tree fruit yield was plotted against tree circumference at breast height (cbh) for the harvested individuals. Regression equations were developed to assess the relationship between fruit productivity and tree girth.

Marketing of Selected Species.—Three prominent markets of Sikkim State, namely Gangtok, Namchi, and Singtam, were surveyed every other week for one year. For each fruit type, data about its period of availability, number of retailers involved per week in its trade, quantity sold, and gross income to the retailer from its sale.

RESULTS

Characteristics of Forest Stands and Status of Wild Edible Plants.—Table 1 provides details of all the sampled forest stands ranging from elevations of 400–2600 m in the Sikkim Himalaya. Of eight stands sampled, three are in the Reserve Forest, one is in Khasmahal forest, three are in Community Forest and one is in the Private Forest. The Reserve Forest areas generally do not suffer any severe anthropogenic pressure from fuel and timber collection. Field visits and discussion with local people revealed, however, that people do collect fodder and various other NTFPs, which also include wild edible plants. Khasmahal Forests are supposed to fulfill villagers' need for fuel, fodder, and timber, and thus bear maximum pressure. The Community and Private Forests generally have higher proportions of the species preferred for their subsistence value. The Reserve Forests (Stands I, II, VIII) maintain high diversity of species with high density and basal cover, which is expected in view of low anthropogenic pressure in these forests. Stand II was in the most inaccessible area. Even so, people collect wild edible plants there. The Khasmahal Forest (Stand VII) showed low density and basal cover due to high anthropogenic pressure. The Community Forests (Stands IV, V, VI) were also in fairly good condition, though the Private forest (Stand III) was highly exploited due to individual family demands. The presence and absence of different species along with their common names is presented in Table 2. Altogether 143 tree species were identified. Stand II had the most species (30), closely followed by Stand VIII (29 species). Data concerning the phytosociology of each stand discussed below are presented in Table 3.

Stand I. This forest stand occurs at elevations of 400–700 m, and represents a typical subtropical forest of the Eastern Himalayan region. According to Forest Department records the forest stand was originally dominated by *Shorea robusta*;

TABLE 1.—Characteristics of the forest stands/sites sampled for vegetation structure and regeneration of selected wild edible species.

Site characteristics	Forest stands/Sites							
	I	II	III	IV	V	VI	VII	VIII
Location	Mamkhola	Raileykhola	Chhota-Singtam	Samdung	Central Pandam	Yuksam	Pangthang (lower)	Tendong-Tifintop
District	Darjeeling	Darjeeling	South Sikkim	East Sikkim	East Sikkim	West Sikkim	East Sikkim	South Sikkim
Elevation range	400–700 m	450–900 m	860–1050 m	800–1400 m	1200–1500 m	1200–1600 m	1500–1900 m	1700–2600 m
Forest category	Reserve	Reserve	Private	Community	Community	Community	Khasmahal	Reserve
Total number of tree species in stand	23	30	23	16	23	12	15	29
Total no. of wild edible species in stand*	7	7	5	4	4	3	3	9
Dominant tree species	*T. grandis–S. robusta*	*C. indica–S. robusta*	*S. wallichii–Albizia*	*A. nepalensis–E. indica*	*F. roxburghii–S. axillaris*	*C. tribuloides–E. indica*	*E. acuminata–S. theifolia*	*O. lamellosa–C. tribuloides*
Standing trees (ha^{-1})	711	600	280	393	495	420	350	715
Basal area ($m^2 ha^{-1}$)	43.52	48.54	19.45	21.66	27.70	51.64	37.75	91.27
Biotic pressure**	Medium	Low-medium	High	High	Selective	Selective	Very high	Low
Total density of all wild edible species (individuals ha^{-1})	180	150	100	105	135	69	55	155
Basal area of all wild edible species ($m^2 ha^{-1}$)	9.89	11.80	3.35	4.11	7.35	19.90	16.15	17.12
Total stand regeneration (ha^{-1})	NR	3820	1655	1710	2060	2786	3138	4700
Regenerating of wild edible plants (ha^{-1})	NR	1560	725	695	730	765	503	230

* Details of the species is provided in Table 2; NR—data not recorded.
** "Biotic pressure" is a qualitative assessment based on field observations; it is based on the number of trees cut and lopped and the quantity of NTFPs and fodder collected in each forest stand.

TABLE 2.—Presence (+) of tree species and wild edible plants at different forest stands in the Sikkim Himalaya.

Species	Local name*	Forest stands							
		I	II	III	IV	V	VI	VII	VIII
Acer campbellii Hk.f. & T.	kapase	–	–	–	–	–	+	+	+
Acer oblongum Wall.	phirphire	–	+	–	–	–	–	–	+
Albizia procera (Roxb.) Benth.	siris	–	–	+	+	–	–	+	–
Albizia stipulata Boiv.	rato-siris	–	–	–	–	+	–	–	–
Alnus nepalensis Don.	utish	–	–	–	+	–	–	+	–
Amoora wallichii King.	lahsune	+	+	–	–	–	–	–	–
Artocarpus lakoocha (Roxb.)	badar	–	+	–	–	–	–	–	–
Artocarpus sp.	kathal	–	–	+	–	–	–	–	–
Baccaurea sapida (Roxb.) Muell.-Arg.	kusum	+	+	–	–	–	–	–	–
Bambusa nutans (Wall. ex Munro)	choya bans	–	+	–	+	+	–	–	–
Bambusa sp.	nibabans	–	–	–	–	+	–	–	–
Bauhinia variegata L.	tanki	+	+	–	–	–	–	–	–
Beilschmiedia roxburghiana Nees.	tarsing	–	–	–	–	–	–	+	+
Betula alnoides Buch.-Ham.	saur	–	–	+	–	–	–	–	–
Betula cylindrostachys Wall.	saur	–	–	–	–	–	–	–	+
Bombax malabaricum DC.	semal	–	–	–	–	+	–	–	–
Brassaiopsis mitis Clarke	chuletro	–	–	+	+	+	–	–	–
Bridelia retusa (L.) Spreng.	gayo	+	–	–	–	–	–	–	–
Callicarpa arborea Roxb.	guyilo	+	–	–	–	–	–	–	–
Casearia tomentosa Roxb.	barkule	–	+	–	–	–	–	–	–
Castanopsis indica A. DC.	dhalne katus	+	+	+	–	+	+	–	–
Castanopsis tribuloides A. DC.	musure katus	–	–	+	–	–	–	+	+
Celtis tetrandra Wall.	khari	–	–	–	–	–	–	–	+
Cinnamomum impressinervium Meissn.	sisi	–	–	–	–	–	–	–	+
Cryptomeria japonica Don.	dhupi	–	–	+	+	–	–	–	–
Dendrocalamus sikkimensis Gamble.	bhalubans	–	–	–	–	+	–	–	–
Dendrocalamus strictus (Roxb.) Nees.	bans	–	–	–	+	–	–	–	–
Diploknema butyracea (Roxb.) Lam.	chiuree	–	+	+	–	–	–	–	–
Duabanga grandiflora (Roxb. ex DC)	lampatey	–	+	–	–	–	–	–	–

TABLE 2—(continued)

Species	Local name*	Forest stands							
		I	II	III	IV	V	VI	VII	VIII
Echinocarpus dasycarpus Benth.	gobrey	−	−	−	−	−	−	−	+
Elaeagnus latifolia Linn.	muslendi	−	−	+	−	−	−	−	−
Elaeocarpus sikkimensis Mast.	bhadrasey	−	−	−	−	−	−	+	+
Emblica officinalis (Gaerth.)	amla	+	+	−	−	−	−	−	−
Endospermum chinense Benth.	setikath	−	−	−	−	−	−	+	+
Engelhardtia spicata Bl.	mahua	−	+	+	−	+	+	−	+
Eriolobus indica Schn.	mehal, likung	−	−	−	+	−	+	−	−
Erythrina sp.	phaledo	−	−	−	+	−	−	−	−
Eurya acuminata DC.	jhingni	−	−	−	−	−	+	+	+
Evodia fraxinifolia HK.f.	khanakpa	−	−	−	−	−	−	+	+
Ficus bengalensis L.	bar	−	−	−	−	+	−	−	−
Ficus benjamina L.	kabra	−	−	+	−	+	−	−	−
Ficus cunia Ham.	khaniu	−	−	−	+	+	−	−	−
Ficus elastica Roxb.	labar	−	+	−	+	−	−	−	−
Ficus hirta Vahl.	khasre	−	−	−	−	+	−	−	−
Ficus hispida L.	khasrey	−	−	+	−	−	−	−	−
Ficus hookerii Corner	nebara	−	−	−	+	−	−	−	−
Ficus nemoralis Wall.	dudhilo	−	−	−	−	+	−	−	−
Ficus roxburghii Roxb.	nebara	−	−	+	+	+	−	−	−
Gmelina arborea L.	khameri	−	+	−	−	−	−	−	−
Gynocardia odorata R. Br.	gante	+	−	−	−	−	−	−	−
Gynocardia odorata R. Br.	gantey	−	+	+	−	−	−	−	−
Ilex sikkimensis Hk. f.	lisey	−	−	−	−	−	−	−	+
Juglans regia L.	okhar	−	−	−	−	−	+	−	+
Leucosceptrum canum Sm.	ghurpis	−	−	+	−	+	−	−	+
Litsaea citrata Bl.	siltimur	−	−	+	−	+	−	−	−
Litsaea oblonga Wall.	kalipahenle	−	−	−	−	−	−	−	+
Litsaea polyantha Juss.	kutmero	−	−	+	−	+	−	−	−
Lyonia ovalifolia (Wall.)	angeri	−	−	−	−	−	+	−	+
Macaranga pustulata King.	malata	+	−	−	−	+	+	−	+

TABLE 2—(continued)

Species	Local name*	Forest stands							
		I	II	III	IV	V	VI	VII	VIII
Macaranga sp.	seto-malata								
Machilus edulis King.	lapche kawlo,	−	+	−	−	−	−	−	−
	pumsi, phun-chey	−	−	−	−	−	+	+	+
Machilus gammieana King.	kawlo	−	+	−	−	−	−	+	+
Machilus odoratissima Wall.	lali-kawlo	−	−	−	−	−	−	+	−
Machilus sp.	bhaisi kawlo	+	−	−	−	−	−	−	−
Mallotus philippinensis (Muell.-Arg.)	sindure	+	+	−	−	−	−	−	−
Mangifera indica Wall.	anp	−	−	+	−	−	−	−	−
Mangifera sylvatica (Roxb.)	chuche anp	+	−	−	−	−	−	−	−
Measa chisia D. Don.	bilaune	−	−	+	−	−	+	−	+
Melia azadirachta L.	bakain	−	−	−	+	−	−	−	−
Meliosma thomsonii King. ex Brandis.	dabdabe	−	+	−	−	−	−	−	−
Michelia excelsa Bl.	chanp	−	−	−	−	−	−	+	+
Michelia lanuginosa Wall.	tite-chanp	−	−	−	−	−	−	+	−
Mimosa himalayana Gamble.	arare	+	−	−	−	−	−	−	−
Morus laevigata (Wall.)	kimbu	+	+	+	+	−	−	−	−
Myrica sapida Wall.	kaphal	−	−	−	−	−	−	−	+
Nyssa sessiliflora HK.	lekh chilaune	−	−	−	−	−	−	−	+
Oroxylum indicum Vent.	totala	−	+	−	−	−	−	−	−
Pandanus L.	tarika	+	+	−	−	−	−	−	−
Prunus cerasoides D. Don.	paiyun	−	−	−	−	−	+	−	−
Prunus nepalensis Koch.	arupate	−	−	−	−	−	−	+	−
Prunus persica Batsch.	aru	−	−	−	+	−	−	−	−
Psidium guajava L.	ambak	−	−	+	−	−	−	−	−
Pyrus pashia (Buch.-Hamex Don.)	naspati	−	−	+	+	−	−	−	−
Quercus fenestrata Roxb.	arkholo	−	−	−	−	−	−	−	+
Quercus lamellosa Sm.	book	−	−	−	−	−	−	−	+
Quercus sp.	—	−	−	−	−	−	−	−	+

TABLE 2—(continued)

Species	Local name*	Forest stands							
		I	II	III	IV	V	VI	VII	VIII
Rhododendron arboreum Sm.	lali gurans	−	−	−	−	−	−	−	+
Rhus succedanea L.	bhalayo	−	−	+	+	−	+	+	−
Salmalia malabarica Schott.	semul	−	−	−	−	+	−	−	−
Schima wallichii (DC.) Karth	chilaune	+	+	+	−	+	−	−	−
Shorea robusta (Gaernt. f.)	sakuwa	+	+	−	−	−	−	−	−
Spondias axillaris Roxb.	lapsi, silet-kung, lumsee	−	−	+	−	+	−	−	−
Stereospermum suaveolans DC.	parari	−	+	−	−	−	−	−	−
Symplocos sumuntia Ham.	kholmein	−	−	−	−	−	+	+	+
Symplocos theifolia D. Don	kharane	−	−	−	−	−	+	+	+
Tectona grandis (L. f.)	sagon	+	−	−	−	−	−	−	−
Terminalia belerica (Gaertn.) Roxb.	barrah	−	−	+	−	−	−	−	−
Terminalia myriocarpa (Muell.-Arg.)	panisaj	+	−	−	−	−	−	−	−
Terminalia tomentosa Bedd.	pakhasaj	−	−	+	−	−	−	−	−
Toona cilliata M. Roem.	tuni	−	−	−	−	+	−	−	−
Viburnum cordifolium Wall.	asare	−	−	−	−	−	+	+	−
Walsura tubulata Hiern.	phalame	−	−	−	−	−	+	−	+
Zanthoxylum budrunga Wall.	siltimur	−	−	−	−	+	−	−	−
Unidentified	amphi	−	−	−	+	−	−	−	−
Unidentified	badari	−	+	−	−	−	−	−	−
Unidentified	bakhain	−	−	−	+	−	−	−	−
Unidentified	dayar	+	−	−	−	−	−	−	−
Unidentified	kalikath	+	−	−	−	−	−	−	−
Unidentified	kamlo	−	−	−	−	+	−	−	−
Unidentified	khankar	−	+	−	−	−	−	−	−
Unidentified	kheari	−	−	+	−	−	−	−	−
Unidentified	mahina	−	+	−	−	−	−	−	−
Unidentified	mahony	−	−	−	−	+	−	−	−
Unidentified	pailey	+	−	−	−	−	−	−	−
Unidentified	pilpile	+	−	−	−	−	−	−	−

* First (or only) name listed is Nepali, second is Lepcha, and third is Bhutia.

after selective felling during the early 1980s, however, the stand was replanted with *Tectona grandis* (IVI 40.12) as well as *S. robusta* (IVI 39.87). Other important tree species of the stand were *Schima wallichii, Dysoxylum binectariferum, Baccaurea sapida, Mallotus phillipensis* and *Terminalia myriocarpa.* The forest stand had a density of 711 trees ha^{-1} and a total basal cover of 43.52 m^2ha^{-1}. Edible fruits of *B. sapida, Emblica officinalis,* and *Mangifera sylvatica* were collected; exploitation of two other wild edible types, *Morus laevigata* and *Pandanus* sp., was insignificant. *B. sapida* showed an even distribution in the stand. All wild edible species together contributed 25.32% of the total stand density, 22.73% of the total basal cover and 25% of the total IVI. *B. sapida* represented 26% of the total density of all wild edible species. Field observations revealed that this species is not only exploited for fruit collection but a significant number of individual trees are either cut or lopped for firewood as well.

Stand II. The Raileykhola forest was studied for the structure and associates of *Diploknema butyracea* and *Baccaurea sapida.* This stand falls in the remotest areas of Kalimpong forest range, and therefore is less affected by fuel and fodder collection. The forest is dominated by *Castanopsis indica* and *Shorea robusta,* both of which occur at high density, basal cover, and IVI. Altogether the wild edible species in the forest contributed 25% of the total stand density and 24.31% of the total stand basal area. Only *D. butyracea* contributed 7.5% of the total density and 11% of the total basal cover of the stand. The site had big individuals of *D. butyracea* of over 1.0-m girth. Among other edible species, the density of *B. sapida* contributed 11% of the total stand density and 3% of the total basal cover. *Bambusa nutans,* which is an edible species, accounts for 7% of the density and 17% of the total basal cover. These three wild edible species are mainly collected for selling in the market. The other important wild edible species in the stand were *Emblica officinalis* and *Artocarpus lakoocha. Bambusa nutans* (IVI 28.55), *D. butyracea* (IVI 25.49), *B. sapida* (IVI 22.73), *Artocarpus lakoocha* (IVI 12.14) and *E. officinalis* (IVI 8.63) contributed a total IVI of 97.54 (nearly one-third of total IVI), which shows that the present forest stand is an important habitat for wild plants of food value.

Stand III. The stand falls in the category of Private Forest, and *Elaeagnus latifolia* was major wild edible species in this stand. Fruits of *E. latifolia* are collected in large quantities and sold in the markets. The site also supports a few other wild edible species, viz. *Diploknema butyracea, Terminalia bellerica* and *Spondias axillaris.* The five wild edible species of the stand had 30.71, 17.22 and 25.97% of the total stand density, basal cover and IVI, respectively. *E. latifolia* and *D. butyracea* contributed more than 50% density of all wild edible species. The stand was dominated by *Schima wallichii* that is used for firewood. *Albizia procera* was the subdominant species, though its density, basal cover and IVI was much less than *S. wallichii.* The total tree density and basal cover of this stand was minimum among all the studied forest stands.

Stand IV. This was a Community stand and *Alnus nepalensis* had naturalized at different locations and showed maximum density (120 individual ha^{-1}), basal cover (7.06 m^2ha^{-1}) and IVI (77.40). *Pyrus pashia, Ficus* sp., *Cryptomeria japonica, Prunus persica* were planted species at this site. The wild edible species *Eriolobus indica* was present and maintained for commercial purposes, though in low quantities. *E. indica* contributed 12% of the total density and 13% of the total basal cover of the stand. All edible species contributed 27% and 19% of the total stand density and basal cover, respectively.

Stand V. In this Community forest stand most of the species are of great economic importance. *Spondias axillaris* (IVI 36.17) and *Ficus roxburghii* (IVI 35.51) are the dominant tree species. The former is kept for edible fruits while the latter for its high fodder value. The bamboo species were also found in the stand, which are essential for various household activities. The forest had a total number of 23 tree species with a total stand density of 495 trees ha^{-1} and a total basal cover of 28.0 m^2ha^{-1}. The four wild edible species in the stand had a combined density of 135 trees ha^{-1}, with *S. axillaris* contributing more than 40% of it. The four types contribute 26.53% of the total basal cover and 28% of the total IVI. Fruits of *S. axillaris* were collected and sold in large quantities.

Stand VI. This Community Forest was dominated by *Castanopsis tribuloides* among nineteen other tree species. The species composition in this site is similar to that of undisturbed stands. The stand contained three wild edible species, viz. *Eriolobus indica, Machilus edulis,* and *Juglans regia.* The overall density of the stand was 420 trees ha^{-1} with a total basal area of 51.64 m^2ha^{-1}. The wild edible species contributed 16.43% to total stand density, 38.54% to total basal area and 21.21% to total IVI.

Stand VII. This forest occurs at elevations between 1500 and 1900 m and falls under Khasmahal Forest category. Due to heavy anthropogenic pressure the site was dominated by secondary species, mainly *Eurya acuminata* and *Symplocos theifolia. Machilus edulis,* which produces edible fruits, was an important species at the site. The stand had a total basal cover of 37.75 m^2ha^{-1} with a tree density of 350 individuals ha^{-1}. *M. edulis* contributed 34% of total basal cover with 25 trees ha^{-1}. The field observations showed that the stand was frequently visited by fruit collectors who gathered fruits of *Elaeocarpus sikkimensis* and *Castanopsis tribuloides,* in addition to those of *Machilus edulis,* for sale in the market. These three species together had a total density of 55 trees ha^{-1}, a total basal cover of 16.15 m^2ha^{-1} and a total IVI of 79.18 in the stand.

Stand VIII. The forest falls in the Reserve Forest category and represents a typical temperate forest community for the Sikkim Himalaya. *Quercus lamellosa* and *Castanopsis tribuloides* were dominant species of the stand. *Machilus edulis, Rhododendron arboreum, Lyonia ovalifolia,* and *Symplocos theifolia* were other associated species of the stand. Besides collection of fruits of *M. edulis,* residents also collect small quantities of *Cinnamomum impressinervium, Castanopsis tribuloides, Myrica sapida,* and *Evodia fraxinifolia* fruits. All the wild edible species contributed 21.68% of total density and 20.49% of total IVI of the stand. The total density of the stand was 715 trees ha^{-1} and the total basal cover 91.27 m^2ha^{-1}, which was maximum among all the studied stands. *M. edulis* contributed 8% of total density and 6% of total basal cover in the stand.

Species Regeneration.—Among the seven stands examined in the regeneration study, the highest number of seedling and saplings was recorded at Stand VIII (4700 individuals ha^{-1}), followed by Stand II (3820 individuals ha^{-1}). Both these stands were in Reserve Forests. The total regeneration was recorded as 3043 individuals ha^{-1} for Stand VII, which is a Khasmahal forest. In Community and Private forests the regeneration was relatively low (Tables 1, 3). Altogether a total of 80 tree species have been recorded regenerating across all the sampled sites. For each stand, 21 out of 30 trees species at Stand II, 18 out of 23 tree species at Stand III, 18 out of 29 species at Stand VIII, and all tree species of Stands IV, VI and VII were found regenerating. Total number of wild edible species regenerating also vary at different stands, and the number was recorded as 9, 5, 5, 5, 5, 6 and 7 at Stands II to VIII, respectively. The contribution of wild edible plants to total regeneration was very high (65%) at Stand III, and fairly good (35%) at Stands IV and V, though it was low in Reserve Forest stands. Discussion with members of the local community revealed that species of low economic value are sometimes uprooted from the Private and Community forests, and therefore many such species do not become mature trees. It can be said that in the Reserve Forests all species are allowed to regenerate, while in Private and Community Forests less valued species are more likely to be removed.

Phenology.—Major phenological events—leaf falling, flushing, flowering, fruiting, and seed dispersal—were recorded for the six species in this study (Table 4).

Leaf fall and flushing. The periodicity of leaf fall and leafing for various species slightly varies at different stands. For the two deciduous trees, leaf fall started in November–December for *Spondias axillaris* and April–May for *Diploknema butyracea.* Flushing was recorded during March–June for various species. Evergreen species do not show any marked leaf fall, and flushing was recorded in small amounts throughout the year. The active leaf growth period was nearly six weeks for *Baccaurea sapida,* eight weeks for *Eriolobus indica,* and four weeks for *S. axillaris* and *D. butyracea.*

Flowering. Flowering was concentrated in a short period of about three weeks in *Eriolobus indica,* six weeks in *Baccaurea sapida,* and seven to eight weeks in other species. Flowering comes to an end in January for *Diploknema butyracea* and *Elaeagnus latifolia,* in April for *B. sapida* and *Eriolobus indica,* in May for *Machilus edulis,* and in June for *Spondias axillaris.*

Fruiting. Completion of flower phase is followed by fruit development. The period of fruit development for different species varied from eight weeks for *Elaeagnus latifolia* and *Diploknema butyracea* and eight to ten weeks for *Baccaurea sapida.* This period was relatively longer for *Eriolobus indica,* and *Spondias axillaris* (16–20 weeks) and more than 20 weeks for *Machilus edulis.* Among all species, fruits of *M. edulis* were bigger in size, followed by *E. indica.* Fruits of *S. axillaris* were smallest in size among the six studied species. Mature fruits were available in April–May for *D. butyracea* and *E. latifolia,* in July–August for *B. sapida,* in October–November for *E. indica* and *S. axillaris,* and December–January for *M. edulis.* Large quantities of fruits were available in the local markets during the period of availability of different fruits.

Fruit Yield.—The fruit yield per tree for six species was measured in different girth classes (age) (Figure 1). All the species varied in their ability to produce fruit (Table 5). *Diploknema butyracea* fruits were harvested from a girth class of 80 to 165 cm and the fruit yield varied from 5 to 155 kg per tree. Tree height, canopy, number of branches and average number of fruits per tree increases with the girth class size, which has a positive correlation with the total fruit yield ($p<0.05$). For

TABLE 3.—Vegetation structure of some wild edible tree species and regeneration status (seedlings + saplings) at different forest stands in the Sikkim Himalaya.

Species[a]	Density (ha^{-1})	A/F[b] ratio	Total basal area (m^2ha^{-1})	IVI[c]	Regeneration (ha^{-1})[d]
Stand I: Mamkhola					
Amoora wallichii	47.00	0.11	1.990	14.64	NR
Baccaurea sapida	47.00	0.02	1.620	19.50	NR
Bauhinia variegata	20.00	0.05	0.800	8.17	NR
Bridelia retusa	13.00	0.07	0.436	5.16	NR
Callicarpa arborea	20.00	0.05	0.590	7.69	NR
Castanopsis indica	33.00	0.04	2.200	14.50	NR
Emblica officinalis	20.00	0.05	1.440	9.64	NR
**Gynocardia odorata*	13.00	0.07	0.856	6.13	NR
Macaranga pustulata	20.00	0.05	1.590	9.98	NR
Machilus sp.	13.00	0.08	1.300	7.15	NR
Mallotus philippinensis	33.00	0.05	0.570	10.75	NR
Mangifera sylvatica	27.00	0.01	3.240	14.71	NR
Mimosa himalayana	6.00	0.14	0.119	2.45	NR
**Morus laevigata*	27.00	0.07	1.000	9.57	NR
**Pandanus* sp.	20.00	0.05	0.260	6.93	NR
Schima wallichii	53.00	0.03	2.300	19.82	NR
Shorea robusta	80.00	0.03	8.400	39.87	NR
Tectona grandis	100.00	0.04	8.100	40.12	NR
Terminalia myriocarpa	33.00	0.05	2.600	15.42	NR
Unidentified-1	13.00	0.08	0.100	4.39	NR
Unidentified-2	13.00	0.08	0.990	6.43	NR
Unidentified-3	13.00	0.08	0.819	6.04	NR
Unidentified-4	47.00	0.02	2.200	19.90	NR
Stand II: Raileykhola					
Acer oblongum	5.00	0.21	0.094	2.32	75
Amoora wallichii	5.00	0.16	0.330	2.82	—
Artocarpus lakoocha	15.00	0.31	4.080	12.14	50
Baccaurea sapida	65.00	0.05	1.320	22.73	505
Bambusa nutans	45.00	0.20	8.380	28.55	540
**Bauhinia variegata*	5.00	0.22	0.150	2.45	25
Casearia tomentosa	5.00	0.24	0.140	2.42	115
Castanopsis indica	8.00	0.23	9.720	47.64	520
Diploknema butyracea	45.00	0.07	5.590	25.49	—
Duabanga grandiflora	20.00	0.20	1.190	8.39	95
Emblica officinalis	20.00	0.09	0.660	8.63	100
Engelhardtia spicata	10.00	0.12	0.561	5.44	110
Ficus sp.	5.00	0.18	0.100	2.35	—
Gmelina arborea	10.00	0.10	0.160	4.63	70
Gynocardia odorata	5.00	0.22	0.250	2.65	105
Macaranga sp.	10.00	0.10	0.320	4.95	
Machilus gammieana	10.00	0.11	1.220	6.79	130
Mallotus philippinensis	20.00	0.08	0.350	7.99	110
Meliosma thomsonii	5.00	0.20	0.270	2.70	35
Morus laevigata	5.00	0.10	0.130	3.72	25
Oroxylum indicum	5.00	0.19	0.090	2.33	65
**Pandanus* sp.	5.00	0.21	0.040	2.22	20
Schima wallichii	50.00	0.40	2.410	22.46	720
Shorea robusta	70.00	0.31	9.870	35.77	—
Stereospermum suaveolans	10.00	0.13	0.230	4.77	—

TABLE 3—(continued)

Species[a]	Density (ha⁻¹)	A/F[b] ratio	Total basal area (m^2ha^{-1})	IVI[c]	Regeneration (ha^{-1})[d]
Unidentified (2 species)	50.00	0.11	0.920	18.12	—
Unidentified (Badari)	10.00	0.10	0.19	4.69	—
Unidentified (Khankar)	5.00	0.20	0.080	2.30	—
Unidentified (Mahina)	5.00	0.17	0.150	2.46	—
Unidentified (4 species)	—	—	—	—	405
Stand III: Chhota-Singtam					
Albizia procera	20.00	0.05	2.217	25.32	5
Artocarpus sp.	5.00	0.22	0.012	9.53	—
Betula alnoides	20.00	0.40	2.058	16.27	—
Brassaiopsis mitis	10.00	0.20	0.698	8.37	65
Castanopsis indica	—	—	—	—	5
Castanopsis tribuloides	—	—	—	—	15
Cryptomeria japonica	5.00	0.20	0.779	7.49	—
Diploknema butyracea	5.00	0.20	0.031	3.64	—
Elaeagnus latifolia	45.00	0.11	0.221	21.64	610
Engelhardtia spicata	5.00	0.20	0.308	5.06	5
**Ficus benjamina*	15.00	0.07	1.357	17.42	—
Ficus hispida	10.00	0.10	0.089	7.42	30
**Ficus roxburghii*	5.00	0.22	0.129	4.14	—
Gynocardia odorata	—	—	—	—	285
Leucosceptrum canum	—	—	—	—	20
Litsaea citrata	5.00	0.20	0.099	3.99	—
Litsaea polyantha	5.00	0.20	0.134	4.17	—
Mangifera indica	5.00	0.24	0.652	6.83	—
Measa chisia	—	—	—	—	275
Morus laevigata	—	—	—	—	15
Psidium guajava	5.00	0.20	0.049	3.73	—
Pyrus pashia	5.00	0.21	0.281	4.93	—
Rhus succedanea	20.00	0.09	0.382	13.72	—
Schima wallichii	55.00	0.04	6.450	99.92	65
Spondias axillaris	5.00	0.24	0.153	4.27	—
Terminalia belerica	5.00	0.20	0.472	5.91	—
Terminalia tomentosa	15.00	0.06	1.316	17.21	—
Unidentified (Kheari)	5.00	0.20	0.242	4.72	—
Unidentified (6 species)	—	—	—	—	270
Stand IV: Samdung					
Albizia sp.	21.00	0.05	1.132	16.27	140
Alnus nepalensis	120.00	0.12	7.060	77.40	400
Brassaiopsis mitis	21.00	0.05	0.748	14.56	110
Bambusa nutans	—	—	—	—	95
Cryptomeria japonica	10.00	0.10	0.191	6.27	20
Dendrocalamus strictus	14.00	0.20	1.450	13.10	—
Eriolobus indica	47.00	0.02	2.720	41.61	180
Erythrina sp.	16.00	0.20	0.880	10.99	95
Ficus cunia	20.00	0.05	1.109	15.92	105
Ficus elastica	20.00	0.10	2.270	21.28	45
Ficus hookerii	18.00	0.04	0.652	16.16	—
Ficus roxburghii	—	—	—	—	110
Melia azadirachta	12.00	0.20	0.263	7.12	—
**Morus laevigata*	10.00	0.05	0.210	6.37	95

TABLE 3—(continued)

Species[a]	Density (ha^{-1})	A/F[b] ratio	Total basal area (m^{2}ha^{-1})	IVI[c]	Regeneration (ha^{-1})[d]
Prunus persica	10.00	0.10	0.144	6.05	60
Pyrus pashia	20.00	0.10	0.382	12.56	50
Rhus succedanea	23.00	0.03	1.660	22.08	115
Unidentified	11.00	0.05	0.815	12.26	15
Unidentified	—	—	—	—	75
Stand V: Central Pandam					
Albizia stipulata	22.00	0.22	1.260	11.16	70
Bambusa nutans	15.00	0.60	1.452	9.54	—
Bambusa sp.	35.00	0.15	2.988	21.69	—
Bombax malabaricum	10.00	0.41	1.203	7.63	—
Brassaiopsis mitis	30.00	0.04	0.725	17.03	75
Castanopsis indica	10.00	0.10	0.928	7.94	65
Dendrocalamus sikkimensis	17.00	0.02	3.137	17.05	270
Engelhardtia spicata	30.00	0.05	1.296	17.22	35
Ficus bengalensis	10.00	0.40	1.386	8.29	35
**Ficus benjamina*	15.00	0.05	1.025	11.89	40
Ficus cunia	5.00	0.20	0.267	3.27	65
Ficus hirta	10.00	0.10	0.258	5.55	90
Ficus nemoralis	25.00	0.04	0.898	15.29	135
**Ficus roxburghii*	60.00	0.03	3.257	35.51	135
Leucosceptrum canum	15.00	0.05	0.484	9.97	110
Litsaea citrata	10.00	0.11	0.379	5.98	—
Litsaea polyantha	14.00	0.05	0.406	9.68	145
Macaranga pustulata	12.00	0.10	0.459	6.27	—
Salmalia malabarica	—	—	—	—	30
Schima wallichii	21.00	0.09	1.269	12.49	465
Spondias axillaris	60.00	0.02	3.070	36.13	245
Toona ciliata	5.00	0.20	0.438	3.87	10
Zanthoxylum budrunga	—	—	—	—	40
Unidentified (Kamlo)	50.00	0.09	0.816	19.83	—
Unidentified (Mahony)	15.00	0.10	0.298	6.70	—
Stand VI: Yuksam					
Acer campbellii	—	—	—	—	150
Castanopsis indica	290.00	0.03	24.495	162.83	390
Engelhardtia spicata	5.00	0.20	3.417	10.25	150
Eriolobus indica	50.00	0.07	9.675	45.27	65
Eurya acuminata	11.00	0.10	0.796	8.80	100
Juglans regia	9.00	0.11	6.026	18.20	5
Lyonia ovalifolia	26.00	0.17	1.667	16.50	25
Macaranga pustulata	6.00	0.19	0.913	6.85	—
Machilus edulis	10.00	0.10	4.211	15.41	70
Measa chisia	—	—	—	—	501
Prunus cerasoides	3.00	0.10	0.028	3.21	—
Rhus succedanea	5.00	0.12	0.073	5.47	—
Symplocos sumuntia	—	—	—	—	80
Symplocos theifolia	—	—	—	—	80
Viburnum sp.	—	—	—	—	375
Walsura tubulata	3.00	0.17	0.315	4.25	55
Unidentified	2.00	0.21	0.024	2.96	—
Unidentified (3 species)	—	—	—	—	740

TABLE 3—(continued)

Species[a]	Density (ha^{-1})	A/F[b] ratio	Total basal area (m^{2}ha^{-1})	IVI[c]	Regeneration (ha^{-1})[d]
Stand VII: Pangthang					
Acer campbellii	—	—	—	—	160
Albizia procera	—	—	—	—	50
Alnus nepalensis	35.00	0.06	2.440	25.08	—
Beilschmiedia roxburghiana	10.00	0.40	6.759	22.48	—
Castanopsis tribuloides	10.00	0.10	0.087	6.54	20
Elaeocarpus sikkimensis	15.00	0.05	1.050	13.97	10
Endospermum chinensis	35.00	0.04	1.780	25.06	—
Eurya acuminata	75.00	0.02	5.290	54.42	260
**Evodia fraxinifolia*	5.00	0.20	0.064	3.31	10
Machilus edulis	25.00	0.04	12.830	49.75	333
Machilus gammiena	—	—	—	—	25
Machilus odoratissima	5.00	0.20	1.317	6.63	—
Michelia excelsa	—	—	—	—	50
Michelia lanuginosa	5.00	0.20	0.724	5.07	10
**Prunus nepalensis*	5.00	0.20	2.178	8.92	5
Rhus succedanea	5.00	0.20	0.397	4.19	—
Symplocos sumuntia	15.00	0.15	0.880	10.08	170
Symplocos theifolia	65.00	0.02	1.530	43.31	1375
Viburnum cordifolium	40.00	0.06	0.421	21.17	410
Unidentified (5 species)	—	—	—	—	250
Stand VIII: Tendong-Tifintop					
Acer campbellii	10.00	0.10	4.970	4.21	25
Acer oblongum	—	—	—	—	205
Beilschmiedia roxburghiana	15.00	0.07	2.800	8.04	20
Betula cylindrostachys	10.00	0.10	0.270	3.58	—
**Castanopsis tribuloides*	115.00	0.03	12.300	41.95	70
**Celtis tetrandra*	15.00	0.07	0.466	5.47	—
**Cinnamomum impressinervium*	10.00	0.10	0.644	4.03	20
Echinocarpus dasycarpus	5.00	0.20	0.190	1.87	—
Elaeocarpus sikkimensis	5.00	0.10	1.600	4.35	—
Endospermum chinense	5.00	0.60	0.540	3.62	—
Engelhardtia spicata	10.00	0.10	0.840	4.21	35
Eurya acuminata	15.00	0.07	0.820	5.86	505
**Evodia fraxinifolia*	15.00	0.07	0.680	5.71	15
**Ilex sikkimensis*	25.00	0.11	0.690	7.12	—
Juglans regia	—	—	—	—	15
Leucosceptrum canum	—	—	—	—	410
Litsaea oblonga	5.00	0.20	0.150	1.82	—
Lyonia ovalifolia	55.00	0.17	5.100	18.96	—
Macaranga pustulata	15.00	0.15	0.263	4.28	—
Machilus edulis	55.00	0.04	5.58	20.51	—
Machilus gammieana	15.00	0.01	3.600	8.91	—
Measa chisia	—	—	—	—	65
Michelia excelsa	15.00	0.15	1.290	5.41	40
**Myrica sapida*	5.00	0.10	0.150	1.82	—
Nyssa sessiliflora	10.00	0.20	0.710	3.13	—
Quercus fenestrata	25.00	0.06	1.890	9.39	—
Quercus lamellosa	80.00	0.03	19.700	43.27	25

TABLE 3—(continued)

Species[a]	Density (ha^{-1})	A/F[b] ratio	Total basal area (m^{2}ha^{-1})	IVI[c]	Regeneration (ha^{-1})[d]
Quercus sp.	40.00	0.10	6.400	16.40	—
**Rhododendron arboreum*	45.00	0.05	9.590	22.50	15
Symplocos sumuntia	—	—	—	—	600
Symplocos theifolia	35.00	0.06	1.200	10.99	1205
Walsura tubulata	10.00	0.10	0.180	3.52	10
Unidentified (2 species)	50.00	0.20	8.660	24.18	—
Unidentified (5 species)	—	—	—	—	1420

[a] Extensively used wild edible species at each stand are shown in bold italics, while minor ones are indicated with an asterisk.
[b] A/F = Abundance/Frequency.
[c] IVI = Importance Value Index (sum total of Relative Frequency + Relative Density + Relative Dominance).
[d] NR = data not recorded.

Eriolobus indica, which is a short tree, individuals of 55.0 to 130.0 cm cbh were harvested to measure fruit yield. The fruit yield varied from 6.56 to 58.0 kg per tree for different girth class size trees. An individual tree had 94 to 1850 fruits per plant. Fruit yield of *Machilus edulis* varied from 5.16 to 75.00 kg per tree for a girth class of 135 to 410 cm, respectively. For this species the per-tree fruit yield increased up to a girth class of 265 cm and thereafter it decreased. Tree individuals are big and attain a height of up to 30 m. Since it is difficult to reach fruit in at the ends of high branches, fruit collectors lop branches to harvest the fruits. In the case of *Spondias axillaris,* trees of 56- to 251-cm girth classes produced 5.60 to 107.00 kg of fruit per tree, respectively. For *Baccaurea sapida,* a total of 2112 to 17,940 fruits have been harvested for trees in the 34- to 70-cm girth class sizes, and productivity varied from 21.50 to 156.00 kg per tree. For *Elaeagnus latifolia,* individuals of 39 cm to 123 cm cbh were harvested to measure their fruit yield, which varied from 9 to 155 kg per plant for different girth classes. Field observations revealed that fruit collectors lopped branches of big trees to harvest fruit, which resulted in low fruit yields the following season.

Marketing.—Among the three markets studied, Gangtok received all six species in high volume. Singtam received *Diploknema butyracea, Elaeagnus latifolia,* and *Spondias axillaris,* while Namchi received *D. butyracea, Machilus edulis,* and *S. axillaris.* Among all the species, *S. axillaris* was sold in maximum quantity, followed by *M. edulis* and *E. latifolia* (Figure 2). The gross income to vendors was also higher from *S. axillaris,* followed by *M. edulis.* The value of the total quantity sold and gross income from the six species presented in this investigation is probably on low side, as many retailers also sell the fruits in small quantities outside the main market directly sold to individuals or households.

Economics of Production of Pilot Stands.—To illustrate the value of cultivating forest trees, potential yields and economic returns of fruit-growing under a variety of conditions were estimated based on observations of wild-growing trees. The total number of trees for each species that could be accommodated per hectare plan-

TABLE 4.—Period of active and cessation of growth of leaf, flower and fruit formation in six selected wild edible species in the Sikkim Himalaya.

	Leaf		Flowers		Fruit	
Wild edible species	Active growth period	Cessation of growth	Flower bud opening	Flowering ends	Fruit formation	Maturation/ dispersal
Baccaurea sapida	Mar I–April II	Apr III	Feb IV–Apr I	Apr II	Apr III	Jul–Aug
Diploknema butyracea	Jun I–Jun II	Jun IV	Nov–Dec	Jan IV	Feb–Mar	Apr–May
Elaeagnus latifolia	Year-round	—	Dec–Jan III	Jan IV	Feb–Mar	Apr–May
Eriolobus indica	Apr–May	Jul	Mar III–Apr II	Apr III	May	Oct–Nov
Machilus edulis	Year-round	—	Mar–Apr	May	May–Jun	Dec
Spondias axillaris	Apr IV–May IV	Jun IV	May–Jun	Jun	Jun	Sep–Nov

I, II, III and IV refer to the first, second, third, and fourth weeks of the respective month.

TABLE 5.—Mean tree characteristics and fruit yield for six selected wild edible species in the Sikkim Himalaya.

			Tree spread (m)				
Species	Girth at breast height (cm)	Tree height (m)	N–S	E–W	No. of fruit per branch	Total no. of fruits per plant	Total fruit yield/tree
Baccaurea sapida	54.36 ± 6.00	6.40 ± 0.54	5.05 ± 0.37	5.15 ± 0.38	113 ± 14	8265 ± 2060	72.44 ± 16.80
Diploknema butyracea	133.19 ± 9.70	14.37 ± 3.80	8.26 ± 0.82	8.72 ± 0.52	296 ± 74	6538 ± 1991	52.12 ± 16.01
*Elaeagnus latifolia**	94.00 ± 11.40	10.94 ± 1.31	—	—	69 ± 10	4860 ± 1403	59.68 ± 16.85
Eriolobus indica	91.12 ± 9.46	8.04 ± 0.38	5.84 ± 1.00	5.45 ± 0.88	43 ± 9	888 ± 125	28.27 ± 7.63
Machilus edulis	243.89 ± 28.84	21.05 ± 5.55	8.38 ± 1.81	8.26 ± 1.83	37 ± 10	4066 ± 315	67.18 ± 7.35
Spondias axillaris	162.81 ± 21.14	16.50 ± 2.61	13.31 ± 2.27	10.53 ± 2.13	195 ± 61	5317 ± 2229	57.36 ± 22.67

* Liana (woody climber).

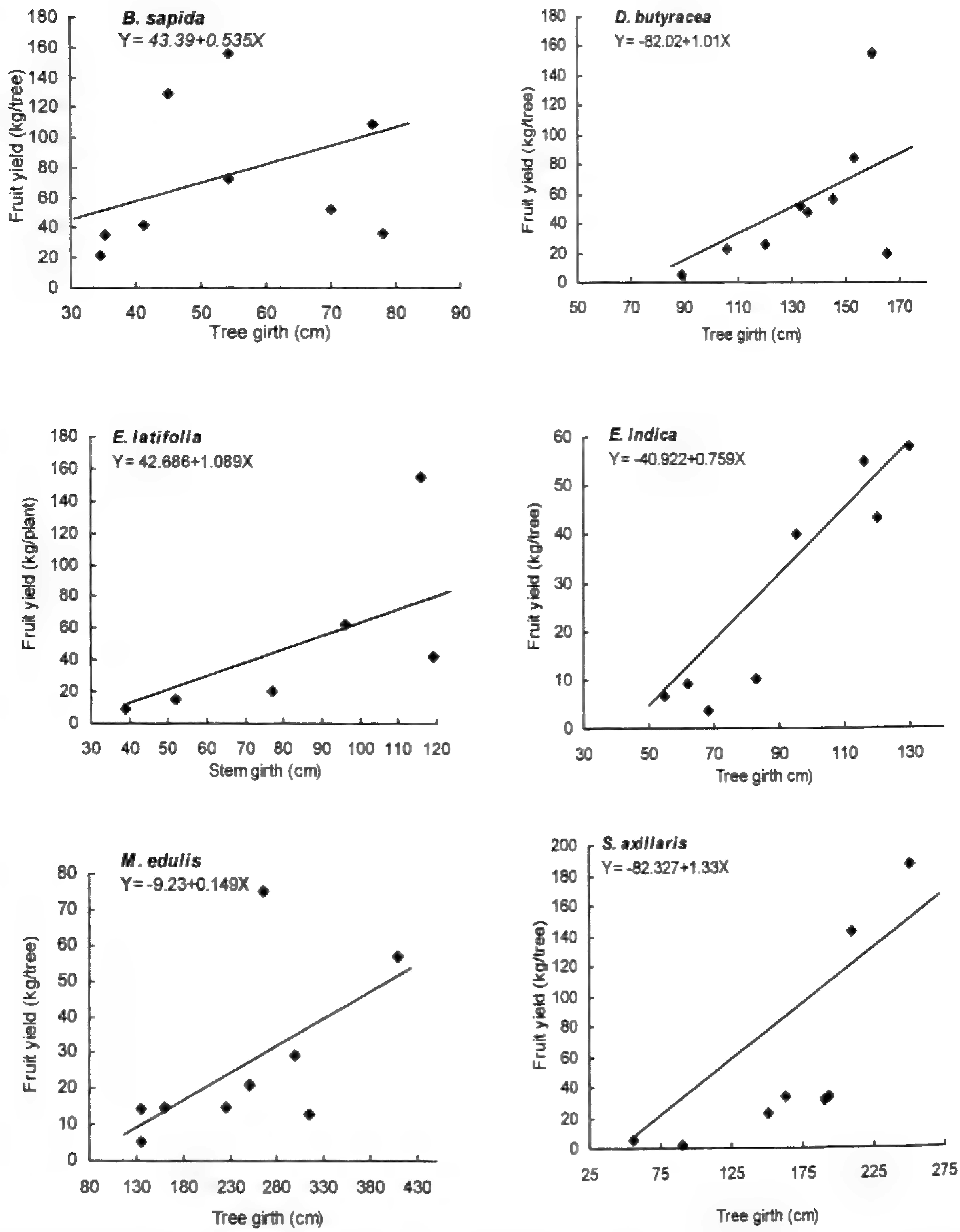

FIGURE 1.—Plant girth (cm) and fruit yield (kg/plant) of different wild edible species in the Sikkim Himalaya. In regression equation, Y is fruit yield and X is tree girth. R values: *B. sapida* (0.192), *D. butyracea* (0.282), *E. latifolia* (0.411), *E. indica* (0.871), *M. edulis* (0.262), *S. axillaris* (0.545).

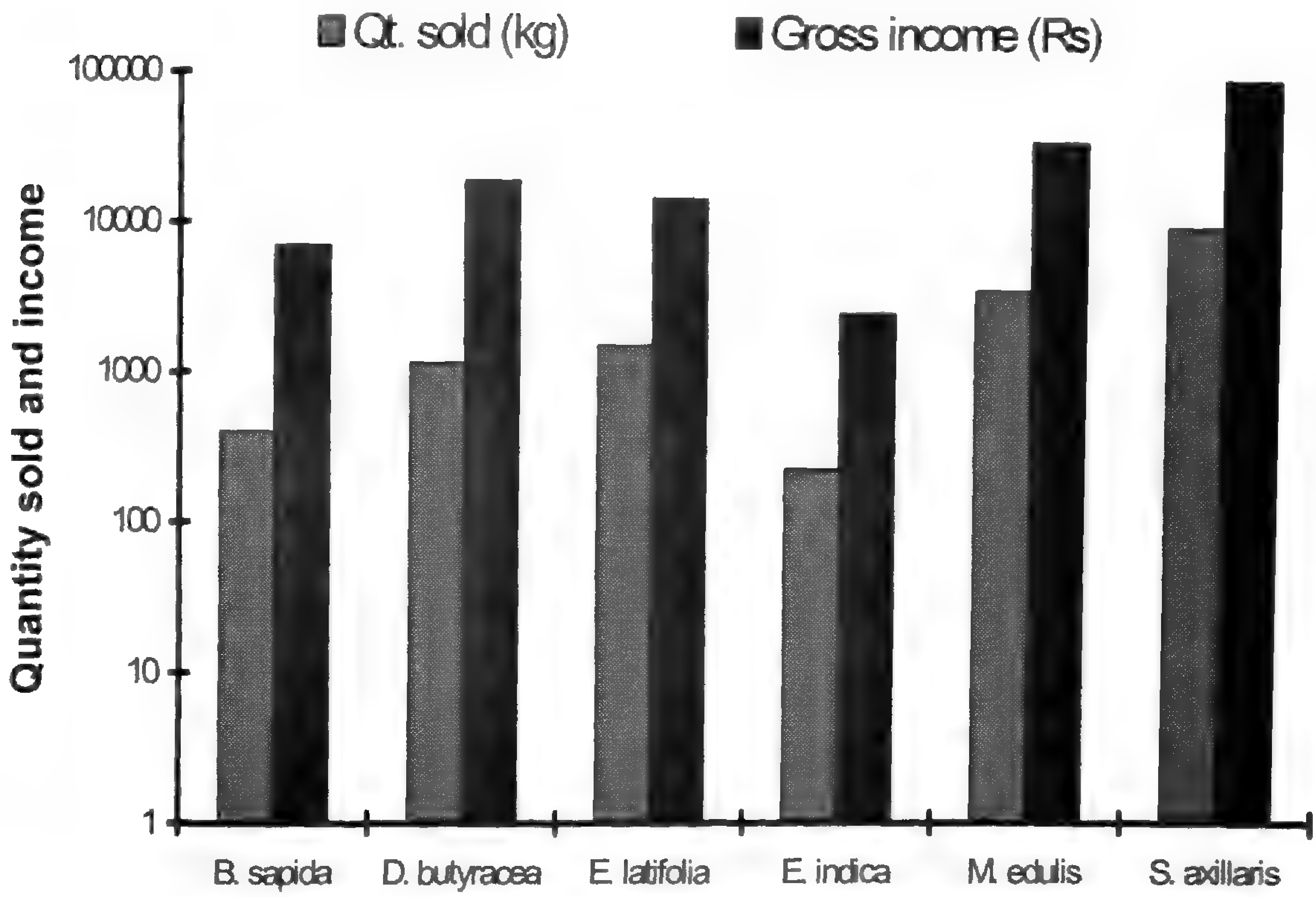

FIGURE 2.—Marketing of the six selected species and gross income from selling the fruits.

tation is calculated based on tree-spread (total canopy area covered by each species) (Table 6). *Spondias axillaris,* which has the largest area under each individual tree due to its broad canopy, could accommodate a planting of only about 180 mature tree ha $^{-1}$. In contrast, *Baccaurea sapida* has the smallest area covered by each tree, so nearly 450 trees ha $^{-1}$ could easily be accommodated in a pure stand. In principle, *B. sapida* would give the highest income among all the species if grown in a pure stand. (Note that monocropping of trees that evolved in a diverse forest might not be the best way to cultivate them, but at this point in our research it is important to present alternatives to cutting down forest stands; see Bandeira et al. 2002.) *Machilus edulis, S. axillaris,* and *Diploknema butyracea* may be grown in

TABLE 6.—Expected economics of production of pilot stands of each individual wild edible species.

Species	Mean tree spread (m^2)	Expected mature tree density in a pure plantation (trees ha $^{-1}$)	Expected annual fruit yield* (tons)	Retail prices/kg	Gross income (Rs.)
Baccaurea sapida	20.40	450	32.60	10.00	325,980
Diploknema butyracea	36.60	275	14.33	8.00	114,664
Elaeagnus latifolia	44.50	225	13.43	8.00	107,424
Eriolobus indica	25.00	400	11.31	8.00	90,464
Machilus edulis	54.40	185	12.43	12.00	149,140
Spondias axillaris	60.00	170	9.75	10.00	97,512

* Calculated on the basis of 75% trees bearing fruits; 1US$ = Rs. 47.

wasteland and can provide substantial income to farmers; all aspects of fruit processing, from simple cleaning and grading quality to the manufacture of juices, jams and jellies can add value and double a farmer's income.

DISCUSSION

In the Himalaya a large variety of wild growing plants are used as food and some of them are exploited in large quantities (Samant and Dhar 1997). In the Sikkim Himalaya a total of 190 wild plant species are reported that have food value, of which 49 species are commonly used (Sundriyal 1999; Sundriyal et al. 1998). Wild woody plants that produce edible fruits are very rarely studied. Given the lack of information about their natural associations, densities, regeneration, phenology and fruit yields, they do not receive the attention of foresters and researchers in afforestation (Martin 1995). Six popular wild-growing species that produce edible fruits and have the potential to be exploited commercially were studied in detail to obtain information about their place in the forest structure, phenology, fruit yield, and future prospects in the Sikkim Himalaya. The eight forests we studied all fall in subtropical and temperate zones with different management regimes—Reserve Forest, Community Forests, Khasmahal Forest and Private Forest. The Reserve Forests are managed by the Forest Department, and generally are devoid of any pressure except for the collection of a few non-timber forest products. The management of Community Forests is dependent on the entire village community. After villagers harvest a forest resource, they do not return to the same place until the plants have had time to recover. In Khasmahal Forest, however, multidimensional pressure—timber, fuel, fodder, and NTFP collection—result in low stand density. The Private Forests are maintained according to individual family need. Species selection is based partly on economic value, mainly as fuel, fodder, and food; density of such stands is also low.

The total stand species diversity and density was highest in the Reserve Forests, followed by the Community Forests, and lowest in the Khasmahal and Private Forests. Though the total number of wild edible species was highest in Reserve Forest stands, these species contributed just a quarter of the total stand density. Contribution of wild edible species to total stand density was >35% in Private Forest and >25% in Community Forest, which suggests the villagers actively maintain preferred species. In contrast, the contribution of wild edible species to total stand density in the Khasmahal Forest was 15%, which suggests people are less concerned with sustainable use of land they do not own.

The six species we studied were in high demand for their fruits. With the exception of *Machilus edulis* and *Spondias axillaris,* which are upper canopy species, they are middle-story species in the forest stands. Though the collective contribution of all wild edible species to total stand density, basal cover, and IVI was significant, an individual wild edible plant species in each stand contributes much less (<7%), which shows that all these species are associated species in the forest stand and such species are very important for maintaining forest diversity (see Phillips 1993). A few wild edible plants are cut down or otherwise stressed despite the economic value of their fruits. For example, *Diploknema butyracea* is also exploited heavily for fodder as well as for its fruits. Similarly, the wood of *B.*

sapida is also considered good fuel, while *M. edulis* and *S. axillaris* are exploited for timber. The pressure on the wild populations of these species is exacerbated by their low density and low rates of regeneration.

Regeneration of all species in the Reserve Forest was better than in any other forest category. This could be attributed to substantial fuel and fodder removal in Khasmahal and Private forests. However, the percentage contribution of wild edible species to total stand regeneration was much higher in Private and Community Forests (35–65%) than in the Reserve Forest. To some extent, villagers manipulate regeneration by uprooting certain undesirable species and promoting wild plants of food and other economic value in Private and Community forests. The six selected wild edible species showed poor regeneration in comparison to many other tree species in their respective forest stands, however. Local people collect fodder from the forest floor. In the process, they unknowingly collect seedlings of wild edible species.

Leaves are central to the adaptation of a plant for growth and competitive success, so it is important to understand the periodic progression of leaf growth for species management (Negi and Singh 1992). November through March is the period of leaf shedding for most of the tree species and 80% of the genera complete their bud burst by April in the Sikkim Himalaya (Sundriyal, unpublished data). Generally most wild edible species shed their leaves during winter months. Flowering of the various studied species ends before the monsoon rains. *Diploknema butyracea* and *Eleagnus latifolia* took the least time from fruit formation to maturation, *Baccaurea sapida* and *Spondias axillaris* took an intermediate time, while *Eriolobus indica* and *Machilus edulis* matured most slowly. It can be concluded that generally fruit development and maturation take longer for species with bigger fruit. Fruit maturation and dispersal completed before the rains for *D. butyracea* and *E. latifolia,* during the rains for *B. sapida,* and after the rains and before winter for *S. axillaris, E. indica,* and *M. edulis.* The time of fruit maturation is directly linked with the seed germination. For example, fruit that matures after the rains and during the winter months have a longer dormancy and viability period than those mature during the rains in the six selected species (Sundriyal and Sundriyal 2001b).

Per-tree fruit yield is good enough to provide attractive opportunities for the villagers to collect them. However, fruit collection is highly erratic, because it is not regulated by the community. Often, large tree branches are lopped, because income depends on the amount of fruit collected as quickly and easily as possible. Such practices may lead to depletion of many species from forest areas in years to come. Where forest cover is dense and human population levels are low, forests maintain a good diversity of species, and wild edible fruit trees can yield good harvests. The wild edible species play an important role in enhancing nutrition, particularly for rural populations who can not afford to buy the fruit sold in the market (Sundriyal and Sundriyal 2001a).

Plant collectors visit forest stands to collect fruits of the six species that are the focus of this study. If the desired quantity of fruit is not available, they will collect diverse species of economic value to justify their labor expenditure. In addition to the six studied species, the plant collectors harvest fruits of *Castanopsis tribuloides, Juglans regia, Elaeocarpus sikkimensis, Mangifera sylvatica,* young shoots of various bamboo species, tubers of *Dioscorea, Diplazium,* and *Agaricus* species in large quantities (Sundriyal 1999).

Collection of wild plants plays a major role in the rural economy because farmers sell these plants in the nearby markets. For many poor people, selling wild plants is their only source of income. Generally, most of the wild edible plants are available for a short period, and due to their perishable nature they are sold at low prices (Sundriyal et al. 1998). Fortunately, all species studied in this investigation have high potential for value addition (Sundriyal 1999), as is being demonstrated for some wild plants in the other parts of the Himalaya (Dhyani and Khali 1993; Maikhuri et al. 1994). Cultivation of the six most desirable types would therefore reduce pressure on all forest plants.

Interviews with the villagers revealed that they are willing to raise all the selected species in their farms. The seeds of these wild edible species show good germination rates when they are raised in a nursery (Sundriyal and Sundriyal 2001b). Unfortunately they are not yet included in the plantation schemes undertaken by any state government or department. Obtaining a supply of such seedlings is a real problem if these species are to be grown by farmers. There is a need to ensure a supply of quality seedlings to farmers, which will have significant benefits for the adoption of these species in agroforestry systems.

Future Prospects.—Disturbance has become widespread in most of the forests in the Sikkim Himalaya. Therefore, information on species composition, growth, regeneration, other phenological characteristics, and sustainable harvest levels is important if we are to rejuvenate the severely stressed forests and individual trees. This is particularly critical for plants of low commercial value but that are nevertheless very useful to local people. In wild plant communities, sustained growth of all species in the presence of older plants is necessary to maintain the health of the stand (Singh and Singh 1992). A large number of people are supported on wild food resources in remote areas, and population growth will lead to a greater demand for food and other necessities in near future. In some forest stands, the density and regeneration of the species discussed in this report is low and conservation efforts should emphasize these species. As wild food plants are exploited mainly by the local plant collectors, they receive little attention from foresters; therefore, the natural populations are quickly getting depleted. These species are crucial for maintaining diversity of the stands (FAO 1985; Herzog et al. 1998). The wild edible plants may bring sufficient returns if grown in the traditional agricultural system in hilly areas. Each of the six species yields a good quantity of fruits and thus provides high economic returns if properly maintained. An assessment of the economics of the pilot stands for the six selected species reveals that all can produce good returns, especially *Baccaurea sapida*. Furthermore, a simple value addition could enhance the benefits. The wild edible species are also used for fruit, fodder, fuel, and timber collection. Therefore, cultivation of these species as part of an agroforestry program perhaps will also contribute to the conservation of genetic resources. If properly planted and cultivated some of these species can replace staple or commercial fruits, thereby contributing handsomely to the economy of the subsistence farmers in the mountains.

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PLURALISTIC MEDICAL SETTINGS AND MEDICINAL PLANT USE IN RURAL COMMUNITIES, MATO GROSSO, BRAZIL

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ABSTRACT.—The use of medicinal plants and other traditional forms of treating illness in rural communities of Mato Grosso State, Brazil, that nowadays also depend on modern health care facilities is assessed. Forty-four households were surveyed about disease events and the use of modern health care facilities, medicinal plants, and consultation with practitioners of traditional medicine during the six months prior to research. All manufactured medicines, medicinal plants, and other therapeutic products present in the household at the time of the interview were recorded. Ninety-three percent of households reported the use of at least one of the modern medical services available as well as the use of medicinal plants during the previous six months. About 120 plant species were recorded. The associated use of modern and traditional medical services and the importance of medicinal plants in a context of social and economic change are discussed.

Key words: rural communities, medicinal plants, medical pluralism, Brazilian savannah.

RESUMO.—O objetivo deste trabalho foi avaliar o emprego de plantas medicinais e outras formas tradicionais de tratar doenças, em comunidades rurais de Mato Grosso, Brasil, que atualmente contam também com serviços médicos modernos. Foi feito um levantamento em uma amostra de 44 domicílios, sobre episódios de doença e recurso às diversas opções terapêuticas disponíveis, modernas e tradicionais, durante os seis meses anteriores à pesquisa; registraram-se todos os medicamentos industrializados, plantas medicinais e outros produtos de uso terapêutico presentes no domicílio no momento da entrevista. 93% dos domicílios relataram uso de pelo menos um dos serviços médicos oficiais e de plantas medicinais nos seis meses anteriores. Cerca de 120 espécies de plantas foram registradas. Discute-se o uso conjunto de facilidades médicas modernas e recursos terapêuticos tradicionais, como plantas, bem como sua importância num contexto de mudança social e econômica.

RÉSUMÉ.—L'objectif de cette recherche était d'évaluer l'utilisation des plantes médicinales ainsi que d'autres approches traditionnelles dans le traitement des maladies parmi les habitants des communautées rurales du Mato Grosso, au Brésil. Aujourd'hui, ces communautés ont également recours à des centres de médecine moderne. Une enquête s'est déroulée auprès de 44 foyers. Elle portait sur les maladies survenues dans les foyers, la fréquentation des centres de médecine moderne, l'utilisation de plantes médicinales et la consultation de guérisseurs traditionnels, au cours des six mois précédent l'étude. Lors des interviews, on prenait note de tous les médicaments commercialisés, plantes médicinales et autres produits ayant des propriétés thérapeutiques qui se trouvaient présentes dans les différents domiciles. Pendant ces six mois, 93% des foyers ont utilisé au moins l'un des centres de médecine moderne mis à leur disposition tout en faisant appel aux plantes médicinales. Environ 120 espèces de plantes ont été identifiées. De plus, dans cet article, l'utilisation parallèle des centres de médecine moderne et des ressources thérapeutiques traditionnelles, ainsi que l'importance des plantes médicinales sont discutées dans un contexte de changements socio-économiques.

INTRODUCTION

Therapeutic pluralism is common throughout the world and can be understood as the coexistence, within the same society or group, of a number of health care alternatives with diverse origins and treatment foci, representing different systems of medical practice and ideology (Janzen 1971; McGrath 1999; Stoner 1986). Some researchers have found that patients and their relatives, when confronted with illness, may make use of the multiple treatment options available, even when there are clearly established limits and functions ascribed to the different coexisting medical systems. From the viewpoint of users, then, they would be rather complementary than contradictory (Brunelli 1987; Colson 1971; Hamnett and Connell 1981; McGrath 1999). People take a pragmatic view of treatment and are willing to try whatever may be effective.

Some scholars stress the importance of the role played by social and political factors in legitimizing different medical systems within the same society and allowing them to coexist (Janzen 1971; McGrath 1999). In this view, medical pluralism provides patients and their families with an array of disease concepts and treatment alternatives that may be employed not only to obtain resources like prestige, power and material resources, but also to negotiate social relations and define cultural identity (Crandon-Malamud 1991). Likewise, the persistence of folk medicine in cosmopolitan settings where modern health care system is well established is sometimes explained as a means of the subordinate classes to resist impositions of the dominant medical ideology (Loyola 1991). Both pragmatic and sociopolitical views contribute to explain medical pluralism in different settings.

In Brazil, different therapeutic traditions have contributed to the formation of folk medicine. From the sixteenth century on, contact between Iberian and indigenous peoples of various ethnic groups created a complex combination of elements from European and autochthonous medicines; it is often difficult to identify the origin of specific aspects of the folk practices as indigenous, European, or the result of contact (Holanda 1994). African slaves taken to Brazil to work in agriculture and mining further contributed to shape folk medicine. A feature shared by these different therapeutic traditions is the use of plants, at least to some extent, to treat illnesses.

At present, folk or traditional medicine in rural areas of Brazil still retains many aspects of the medicine practised in colonial times. For example, some practices related to humoral theory, especially those aimed at "purifying" the blood and at maintaining health through hot and cold balance, are still very common; the therapeutic use of excreta (like urine and feces) is also found among rural people (Amorozo and Gély 1988; Fleming-Morán 1975; Queiroz 1984). The relative isolation of these populations has contributed to the maintenance of these ideas and to their continuing reliance on local specialists: curers, midwives, and *benzedores*—who heal by praying on (blessing) the ill person—among others. Moreover, these populations exploit their environments very efficiently in search of therapeutic elements; in general they have a solid and long-standing knowledge about procurement and use of medicinal plants.

In the past two or three decades, modern facilities have been brought to countryside; in some areas, government medical services are locally available to rural populations. The introduction of modern medicine adds another option to the pluralistic base already established and does not eliminate people's use of traditional medicine. Instead, in many instances, traditional and modern procedures are employed together (Alexiades and Lacaze 1996; Cândido 1987; Elisabetsky and Setzer 1985; Wagley 1988). But the increasing influence of national culture certainly leads to changes in local medical settings; some kinds of traditional practitioners may disappear or their roles within community life may change (Queiroz 1980). Under the influence of cosmopolitan lifestyles and easy access to modern medical facilities, people may reduce their use of medicinal plants (Nolan and Robbins 1999).

The aim of this work is to assess utilization of traditional forms of treating illness—chiefly the use of medicinal plants—by dwellers in rural communities that nowadays can also depend on available modern health care facilities and to discuss factors that may be affecting this use.

STUDY AREA

The study site is located in Santo Antonio do Leverger Municipality, Mato Grosso State, Brazil, on the left edge of The Cuiabá River, near the Pantanal and about 30 km by paved road south of the state capital, Cuiabá (Figure 1). The dominant natural vegetation is the *cerrado* (Brazilian savannah), which is, to a certain extent, altered by human activities.

This region, formerly occupied by various indigenous peoples, including the Bororo (Viertler 1990), was settled in the beginnings of the eighteenth century by *paulistas*—descendants of Portuguese and aboriginal peoples (mainly from the Tupi group). They came from southeastern Brazil after the discovery of gold. African slaves, possibly of Banto origin (Bandeira 1988), were taken to work in the mines and in sugar cane spirits and sugar factories. The area near the Cuiabá River soon became important for supplying food for people working in mining. The occupation of these lands had been feasible only after the subjugation or expulsion of the local indigenous populations.

When the gold mines were exhausted, the sugar industry began to flourish. In the nineteenth century, sugar and cane spirit production became the most important economic activity. That industry remained very influential in regional politics until the first half of the twentieth century. Later, its importance declined for number of reasons, among them the construction of technologically more advanced factories in other regions (Póvoas 1983).

Mato Grosso State remained relatively isolated from cosmopolitan influences. Its economy stagnated until the mid 1970s. Since that time, the settlement of

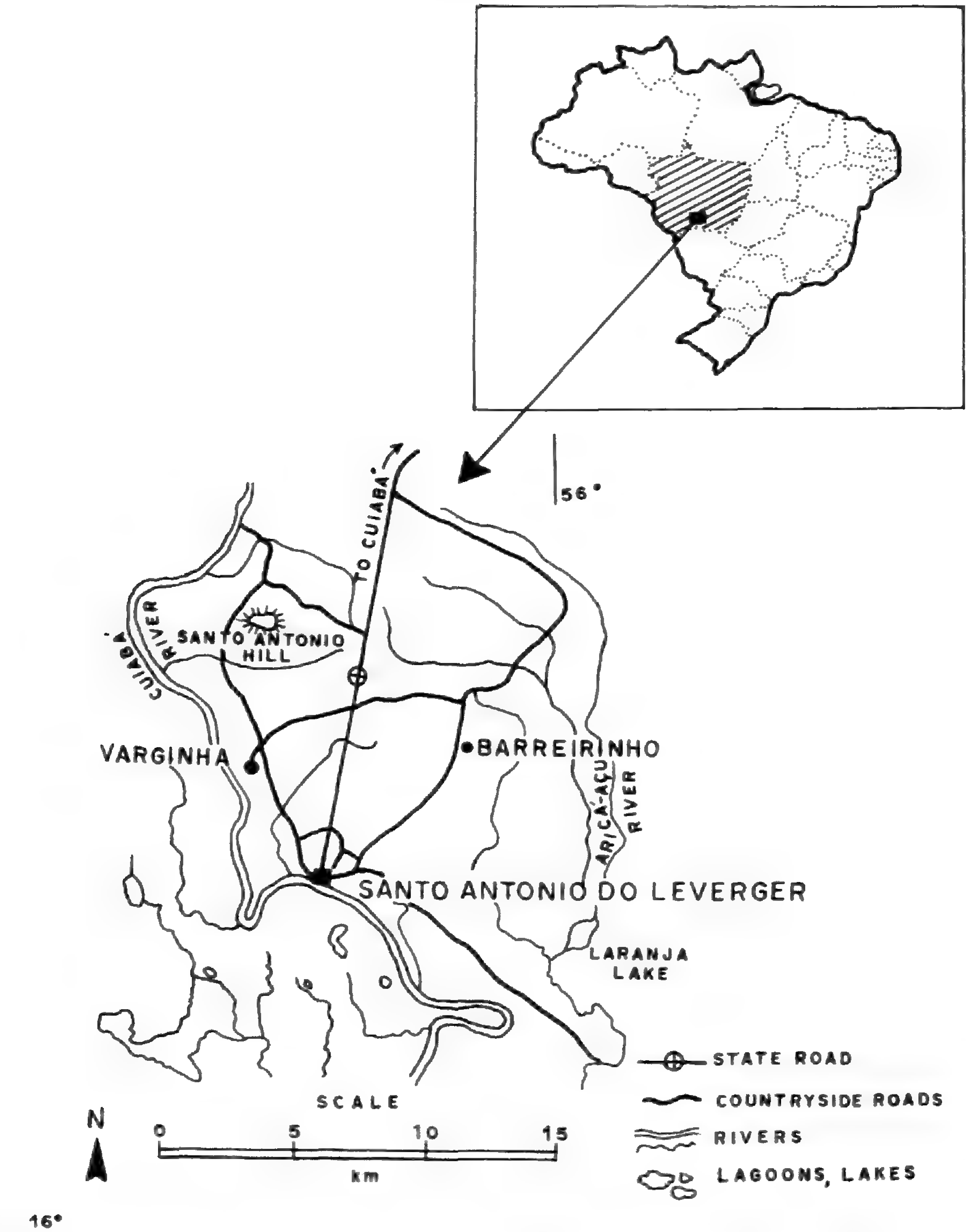

FIGURE 1.—Study area. Source: Fundação de Pesquisa Cândido Rondon, 1991.

farmers from the southern region of Brazil and the establishment of agroindustrial centers in the state brought about changes in land use and social and economic conditions.

In the study area, economy is based on subsistence agriculture, artisanal fisheries, and production of manioc flour for home consumption and sale in the urban market. Modernization—provison of water and electric services, introduction of telecommunication facilities and the enhancement of tourism activities in the area—is rapidly changing this picture, and contact with the national society is intensifying.

Until a decade or two ago, traditional medical services included various types of specialists: midwives, curers, *benzedores,* and some practitioners of Afro-Brazilian sects, locally known as *tenda* or *congá.* Since modern medical facilities have become more accessible, fewer of these specialists are providing services. For example, midwives are no longer training their replacements; at the time of this study, there remained only three or four very old women said to have been in demand as midwives in their time. Curers who have a deep knowledge of medicinal plants and who know how to diagnose ailments by feeling the patient's pulse are now rare, and none were to be found in the area. In contrast, there are many *benzedores.* They constitute the most important local representatives of traditional medicine at present. Besides "blessing" the ill person, they also prescribe medicinal plants or allopathic remedies (Amorozo 1999). Also, a great number of people, mainly those over the age of forty, control a vast repertoire of knowledge about medicinal plants. In previous research, about 230 plant species employed for therapeutic use have been recorded (Amorozo 2002).

Nowadays, state-run health services include a health care center and a hospital in the small town of Santo Antonio and three health care posts in the nearby rural communities. These services attend to the population at no cost and supply, depending on availability, some of the remedies prescribed by the physicians. The health center operates daily, offering services in general medicine, pediatrics, gynecology, and dentistry. It also performs some simple laboratory analyses. The health posts operate only certain days of the week and offer more limited services. In town, there is also one private physician who attends to the local population for free and two commercial drugstores.

METHODS

Fieldwork has been done in the area since the early 1990s, focusing on the ethnobotany of medicinal plants (Amorozo 2002) and on disease concepts and treatment (Amorozo 1999). For the present study, two quarters in the town of Santo Antonio and two rural communities (Varginha and Barreirinho), approximately seven kilometers away from the former, were selected; all these sites have easy access to government medical services. In June 1998, a survey was conducted in a sample of 44 households (20 in the rural zone and 24 in town). Households were selected by systematic sampling, using a sampling interval suited to ensure 20% of the total in the selected places (adapted from Bernard 1988). In general, interviews were held with female householders, but in some cases, male head or other members of the family also took part. Questionnaires recorded data about socioeconomic position, disease events, and the use of health facilities (both modern and traditional) by family members in the six months previous to the research. Vernacular names of medicinal plants used in this period were also recorded. In addition, all the medicines present in the household at the moment of the interview were inventoried; plants and plant material that the interviewed person considered of medicinal use were recorded—whether growing near the household, gathered fresh, or dried. The majority of species had already been collected

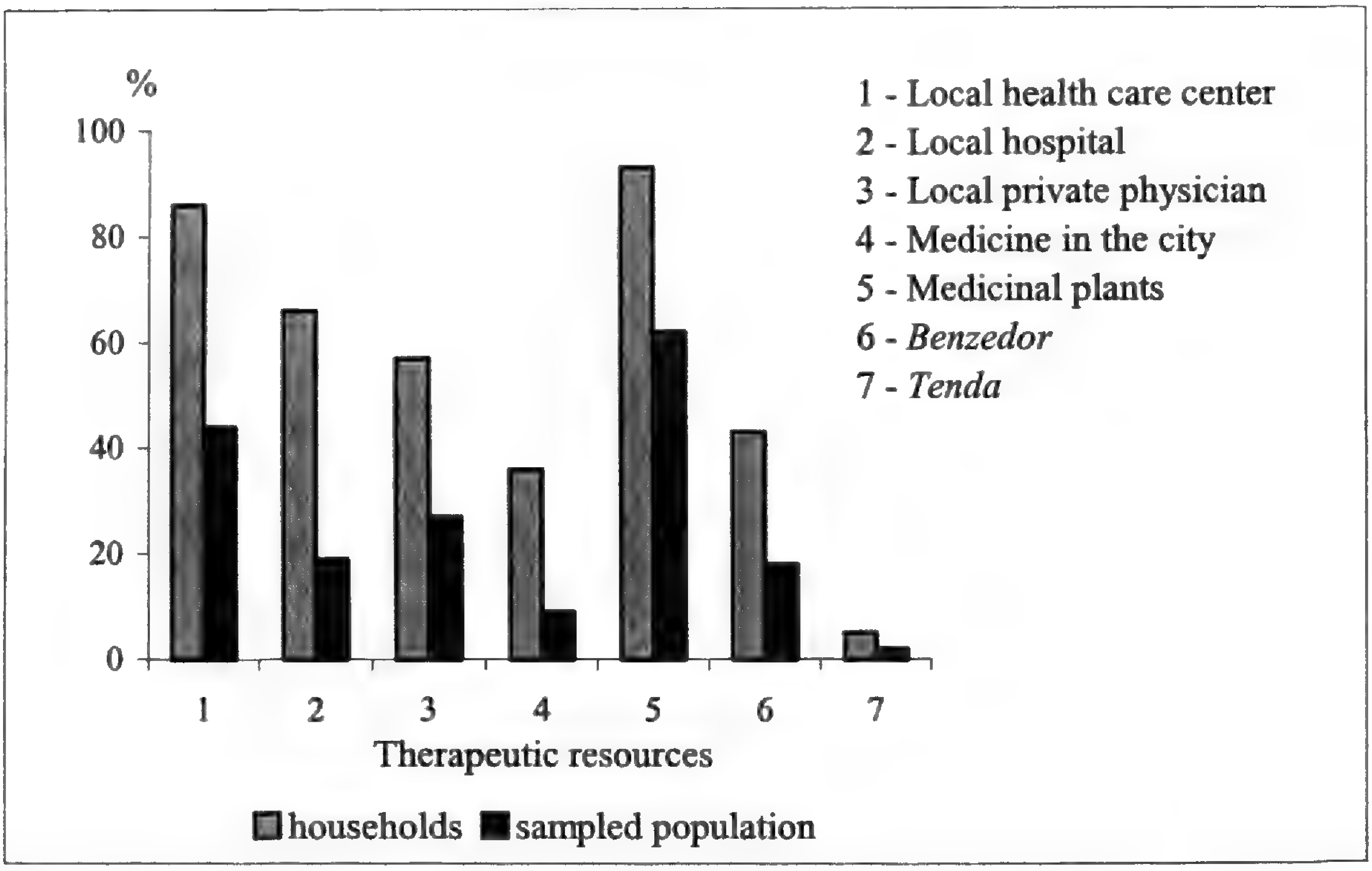

FIGURE 2.—Use frequency of therapeutic resources (number of households = 44; sampled population = 204).

and identified (Amorozo 2002), so collection of botanical material was made, whenever possible, only for those plants that lacked voucher specimens.[1] Data about medical consultations in the area were also gathered in the health center files, encompassing 3320 consultations by general practitioners between June 1997 and June 1998.

An index of therapeutic resources utilization was calculated by age group as follows: TRUI = Σ_i^n N*ri*/N, where N*ri* is the number of users of resource *i* in the age group, and N is the number of persons in the age group. This index rules out the problem of different numbers of people in the age groups, besides condensing data about use frequency in a single figure, making comparisons among them easier. For statistical comparisons, Kendall correlation coefficient, chi-square (Siegel 1975) and binomial test (Ayres et al. 2000) were used.

RESULTS

The sample comprised 204 persons, on average 4.6 per household. Forty-one of the 44 households (93%) reported the use of at least one of the local state-run medical services during the six months previous to the research. Among the available medical services, the local health care center and posts were the most visited by respondents and their families (86% of households and 44% of sampled population). Plants were the most used traditional therapeutic resource; 93% of households and 61% of sampled population used medicinal plants to treat at least one case of illness in this period (Figure 2). Plant-based recipes can be prescribed by anyone, but older, knowledgeable people and *benzedores* are the most sought for such remedies.

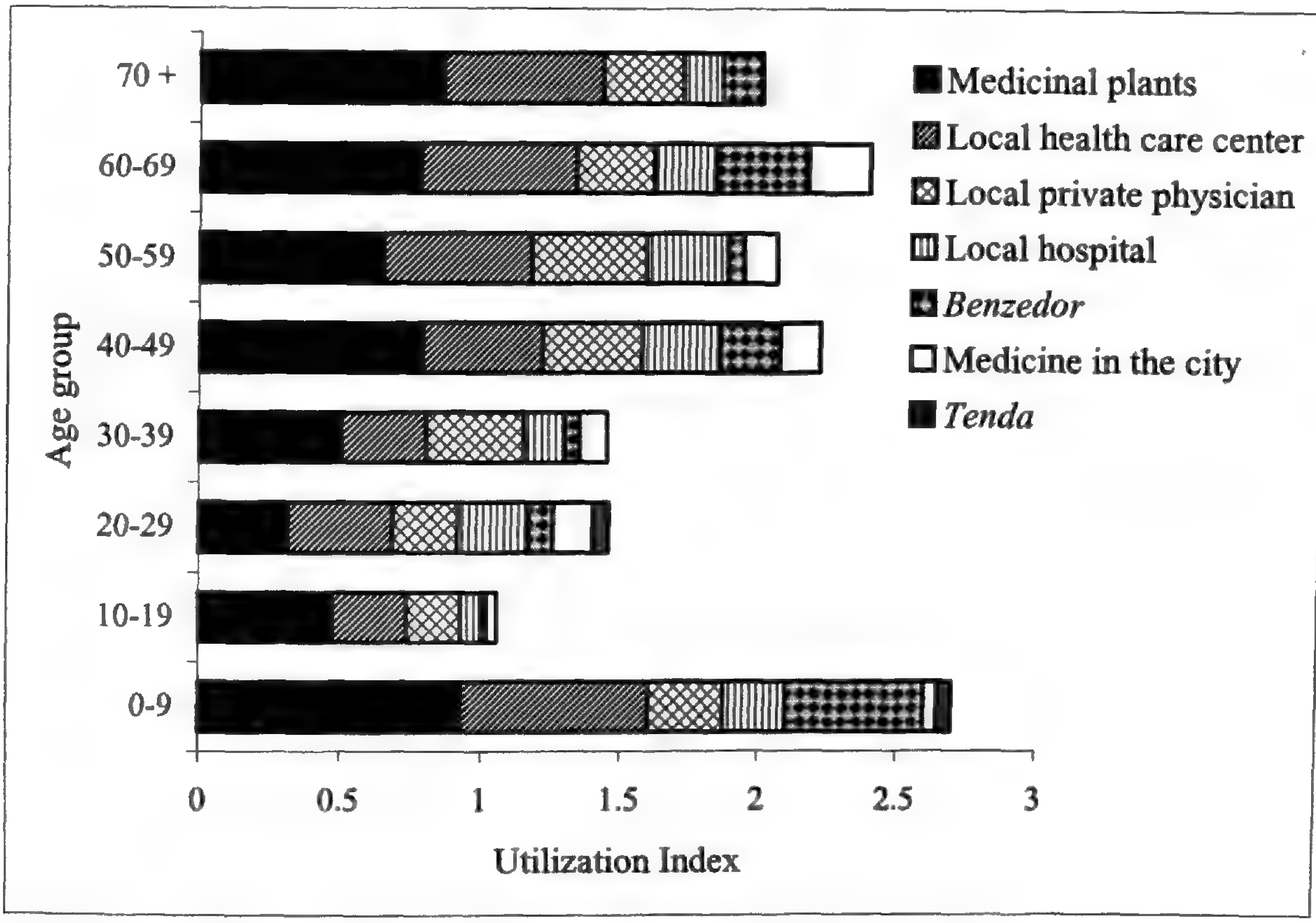

FIGURE 3.—Indices of therapeutic resource utilization by age group.

Differences in the use frequency of therapeutic resources among age classes are to be expected, since people in the prime of life tend to be healthier. In fact, utilization indices (TRUI) were greater for children under 10 and for adults over 40. In the six months prior to research, 93% of children in this age group and 75% of adults over 40 used medicinal plants; they also went to health care center and posts more frequently than did the intermediate age class. *Benzedores* were most sought for treating children under 10 and, to a lesser extent, adults over 40 (Figure 3). Differences among age classes (0–9; 10–39; and 40 and older) by type of therapeutic alternative used were of no statistical significance for medical facilities in Cuiabá, the local private physician and the local hospital. They were significant for the local health care center and posts (χ^2 = 10.32, $p<0.01$), medicinal plants (χ^2 = 14.24, $p<0.001$) and *benzedores* (χ^2 = 34.22, $p<0.001$).[2] For the comparisons between age classes, all the results were significant, except for the use of health care centers and posts by people under 10 and people aged 40 and older. People aged 10–39 used medicinal plants and sought *benzedores* significantly less than either other class (Table 1). Use of therapies of any kind by people over 14 was 63% higher among females than among males.

The majority of illnesses reported in the interviews received some kind of treatment (Table 2). In general, for ordinary indispositions or minor diseases, self-medication was the first step of treatment; it consisted mainly of medicinal plants (*chás caseiros*) and allopathic medicines that can easily be obtained without medical prescriptions.[3] If symptoms persisted or if there were a physician or health service available, people would seek further treatment, even in cases of common

TABLE 1.—Binomial test results for comparisons of therapeutic resources use between age classes.

	Age class† (z values)		
Therapeutic resource	1 × 2	1 × 3	2 × 3
Health center	4.06*	1.54	2.66*
Medicinal plants	5.43*	2.21*	−3.95*
Benzedores	6.54*	3.14*	−3.08*

† 1 = 0–9; 2 = 10–39; 3 = ≥40.
* $p < 0.05$; results not significant in unmarked cell.

ailments. For example, consultation with a health professional took place in more than 30% of the reported cases of influenza and cold symptoms. Likewise, data from the health care center files show that influenza symptoms accounted for almost 6% of consultations by general practitioners between 1997 and 1998. Consultations regarding respiratory and digestive systems ailments, intestinal infections, and helminthiasis accounted for 37% of consultations in the same period. In the rural places studied, in the absence of the physician, who visits only two or three times a week, trained local health agents provided medicines and primary health care.

Medical professionals were sought, locally or in Cuiabá, for serious or acute problems (like heart attack, cerebrovascular accidents, trauma, pneumonia) and undiagnosed illnesses. However, this did not prevent patients from seeking alternative means of healing. For example, two mothers whose young children had been diagnosed with pneumonia reported that they sought government-provided medical care. When the children returned home, the mothers gave them a locally popular tea prepared with some plants and guinea hen feathers in addition to the medicines prescribed by the medical staff.

The combined utilization of modern health services and folk medicine elements, mainly plants, occurred in 45% of reported cases of illness; resort only to modern medicine accounted for 29% of cases, whereas treatment exclusively with plants, and with plants and self-medication with allopathic remedies occurred in 18% of cases, mainly for influenza and cold symptoms (Table 2).

With regard to the medicines inventoried by the time of the interview, allo-

TABLE 2.—Health facilities sought in cases of illness.

Type of health care	Cases (%) (n = 121)*
Medical professionals + traditional medicine (mainly plants)	44.6
Medical professionals	28.9
Medicinal plants	9.1
Medicinal plants + allopathic remedies	9.1
Allopathic remedies	3.3
Allopathic remedies + medical professionals	2.5
Others	1.7
No treatment	0.8

* If more than one person in a household had the same disease at the same time and treated the same way, only one case was counted.

TABLE 3.—Remedies in the households.

	Frequency (%) (n = 44)	Mean	Range	SD	Total
Allopathic medicines	93.2	5.11	0–29	5.19	225
Medicinal plants	88.6	5.86	0–27	6.01	258
Commercial phytotherapics	18.2	0.27	0–2	0.62	12
Miscellaneous*	34.1	1.29	0–10	1.66	34
Plants used the previous 6 months	93.2	4.27	0–13	3.08	188

* Topical antiseptics, medicinal soaps, animal products.

pathic remedies and medicinal plants were found in most households; the mean number of allopathic medicines per household was around five, whereas the mean number of medicinal plants was around six (Table 3). Some households had a greater number of patent medicines and/or medicinal plants, eventually providing these facilities to neighbors in need. There was a significant positive correlation between number of medicinal plants reported to have been used in the six months previous to research and the number of medicinal plants present in the household (Kendall Tau = 0.40437, $p<0.001$) and also between this latter and the number of allopathic remedies present in the household (Kendall Tau = 0.261316, $p<0.01$). Allopathic medicines recorded were mainly analgesics and antipyretics, anthelmintics and remedies for digestive system ailments, antibiotics, vitamins and fortifiers, remedies for urinary tract, hypertension and tranquilizers; antiseptics and antibiotic ointments for treating wounds were also common. About one fifth of the medicines, mainly anthelmintics, antibiotics, vitamins, and analgesics, was supplied free of charge by official health services.

Plant species recorded in the households by the time of the visit numbered 111; about 83 species were mentioned to have been used in the previous six months. In total, about 120 plant species were recorded (Appendix 1). Little more than one-fourth of identified species were native to the *cerrado* or wet areas in the region (Lorenzi 1991; Pott and Pott 1994); cultivated plants accounted for about half of the total plant species. Herbs (37%) and trees (31%) were the most common. Plants cited and/or found in more than 10% of sampled households (Table 4) were mainly cultivated species; at least half of them were exotic species introduced into the area. People aged 40 and older kept on average more than twice as many plants and plant material at home as the group under 40; likewise, mean number of *cerrado* plants and plant material was greater for this age group.

Around 30% of these species were employed to treat illnesses or symptoms of the respiratory system; 20% were used for treatment of gastrointestinal ailments and intestinal worms. Urinary tract ailments, hypertension, disorders related to female reproductive functions (*problemas de mulher*) and wounds were also treated by a variety of plants. Seven species were used to prevent or treat *mau-olho* (evil eye) and envy. It was common to employ the same plant for different diseases.

TABLE 4.—Plant species most frequently present/used in households (%, $n = 44$).

Plant species	Utilization	Present in house-hold	Used last six months
Gossypium barbadense L.	inflammation, "female problems"	23	7
Lippia alba (Mill.) N.E.Br.	tranquilizer	18	14
Coleus sp.	stomach/liver	18	9
Justicia cf. *pectoralis* Jacq.	influenza/cold	18	7
Vernonia condensata Baker	stomach/liver	18	2
Eucalyptus sp.	influenza/cold	14	18
Stachytarpheta cayenensis (L.C. Rich.) Vahl	cough/influenza	14	11
Punica granatum L.	throat inflammation	14	5
Citrus × *aurantium* L.	influenza/cold	11	16
Petiveria alliacea L.	*mau-olho*	11	9
Ruta graveolens L.	"female problems"	11	5
Machaerium aculeatum Raddi	cough/influenza	9	14
Polygonum hydropiperoides Michx.	influenza/cold	7	16
Cymbopogon citratus Stapf.	influenza/cold	5	16
Hyptis spp.	influenza/cold	2	14

DISCUSSION

Data presented above show the combined employment of folk therapies, mainly plants, and modern medicine in almost half the reported disease cases. It is possible that minor complaints were underreported in the recall survey, which could lead to an underestimate of exclusive use of traditional therapies, normally employed in the first place in such cases, or no treatment at all (Brunelli 1987). However, data from the sampled households and from the health center files have shown that even for simple ailments, like influenza or colds, people turn to an official health system professional whenever they can.

The spread of official health care facilities, in the present case, adds more treatment opportunities to a context of health care alternatives constructed after the contribution of diverse influences during the last three centuries. To the practices taken by *paulistas,* already a blend of European medicine of the sixteenth century with medicinal knowledge of indigenous groups from the southeast, therapeutic knowledge of local natives was incorporated. A number of *cerrado* plants used today as remedies were considered *erúbo* (that is, magic or medicinal plant) for the Bororo Indians—e.g., *Hyptis* spp., *Macrosiphonia longiflora, Anemopaegma arvensis, Protium heptaphyllum, Byttneria melastomifolia,* among others (Albisetti and Venturelli 1962; Amorozo 2002; Hartmann 1967). Some plants, like *Petiveria alliacea,* used by African slaves in the eighteenth century to poison their masters (Santos Filho 1977) were also included in this pharmacopoeia.

The new therapeutic options brought about by growing access to modern medical facilities coincide with changes in traditional subsistence and production conditions as well as increased influence of urban ideology on rural areas. The impact of this scenario on former therapeutic practices and practitioners is different in each case: for example, for the study area, midwives are no longer necessary because access to institutional obstetric services is relatively easy. On the other hand, *benzedores* still play an important role, not fulfilled by modern medicine. Culturally recognized ailments that are not considered by modern medicine, like *quebrante, mau-olho* (evil eye), and *arca-caída,* are treated exclusively by *benzimento* (blessing) (Amorozo 1999). This uniqueness partly explains the great popularity *benzedores* enjoy in the area. But, *benzedores* are also sought when the therapeutic focus of an illness episode concentrates upon elements of modern medicine and in situations of emotional distress, which suggests psychological support plays an accessory role. For instance, the mother of a teenager who was experiencing a delicate emotional situation reported she had taken her daughter to a psychologist or psychiatrist in Cuiabá and also to a local *benzedeira.*

Medicinal plants were ordinarily employed to treat ailments like influenza, colds, gastrointestinal disorders and intestinal worms, sometimes in combination with allopathic medicines. Plants aimed at treating these ailments were the most frequently kept at home. The use of plants for these purposes is also common in other parts of Latin America (Bennett and Prance 2000; Trotter 1981) and Brazil (Amorozo and Gély 1988; Hanazaki et al. 1996; Silva-Almeida and Amorozo 1998). It is noteworthy that these ailments accounted for a great proportion of consultations in the health center as well.

People aged 40 and older kept much more plants/plant material at home and made use of them most frequently. Plants were also commonly used to treat small children; young mothers commonly seek advice and plants from older relatives or neighbors.

In sum, the majority of the sampled population used traditional as well as modern therapeutic facilities during the recalled period, taking advantage of all treatment opportunities available to them. The following description illustrates well this therapeutic syncretism.

During earlier fieldwork in Santo Antonio, I collected an account of an illness event, where a woman about 40 years old had been struck by facial paralysis of unknown etiology. In the first few days of her disease until the onset of the paralysis, she complained of an intense headache, blurred vision, and weakness. She first tried some home remedies prepared with plants and a commercial phytotherapic, all recommended by relatives and friends. Then she consulted a physician in town and the next day, a neurologist in Cuiabá; both prescribed allopathic medicines. During the first days of her disease, she also sought a *benzedor,* who blessed her and prescribed medicines and baths prepared with plants and other ingredients. Her illness lasted about one month; during this time, she consulted one more physician, a homeopath in the city, three other *benzedores,* one physiotherapist, besides taking advice from a handful of relatives and acquaintances. She used whatever medicine was prescribed to her, both internally and externally, which included several remedies prepared with thirteen plant species, six allopathic and two homeopathic medicines, among others. She and her relatives also prayed and made promises to the Roman Catholic saints in order to ensure her cure.

Though a rather extreme example, this case can give us some insights about the way people in Santo Antonio deal with illness events. In a very short period of time, the patient turned to almost all the therapeutic options available to her, traditional and modern. There was not time enough to evaluate the treatment efficacy before she changed to another therapy and also no complete shift would take place among treatments. Instead, the whole array of therapeutic resources at hand was exploited virtually simultaneously. Moreover, she made no distinction between different approaches by medical doctors, employing both allopathy and homeopathy.

A remarkable feature of this situation is the interest of relatives, friends and neighbors in restoring the well-being of the diseased person. Everyone took pride in suggesting a recipe, based on their own experience, that of relatives or hearsay. That is, the community was involved in the illness episode, a situation characteristic of traditional rural settings. On the other hand, the array of therapeutic choices has increased, since people can either seek folk health agents and/or the new options made available by the broadening of official health services coverage. Feierman (1979), discussing the size and composition of therapy-managing groups of kinsfolk in Africa argues that, in periods of great social mobility, the extendend kinship network tends to cross various lines as related to instruction, social class, rural or urban residence, thus broadening the range of therapeutic preferences. Though one can not talk of 'therapy-managing group' proper in the present case, social and economic mobility in the area tends to have a similar effect. Also, in Santo Antonio, exchanges with society at large are more intense today due to increased tourism and the development of other economic activities in the region. Other authors have already stressed the predominance of pluralism in Brazilian rural societies undergoing social and economic changes due to external influences (Cândido 1987; Wagley 1988).

It seems that in the case of Santo Antonio, this pluralism is sometimes expressed as a sort of therapeutic opportunism. To a certain extent, the availability of free official health facilities encourages this behavior. But, medical services offered locally do not entirely meet people's expectations. For example, there are many complaints about the frequent change of physicians in the health center and posts, which, according to users, hinders patients attendance. They also view clinical and laboratory examinations performed there as superficial, which makes them feel unsupported by medical personnel. Moreover, here, as in many parts of rural Brazil, provision of medical facilities for poor people is a common means of obtaining political advantage and is often used for electoral purposes. This can be done, for instance, by hiring private physicians to tend the population at no cost in times of election.

On the other hand, people continue to turn to traditional ways of treating illnesses that are still available. But, as subsistence activities (like manioc flour production and fishing) become increasingly directed toward production for market and opportunities for wage labor increase, as is the case in the area, people begin to lose control of their working conditions. This limits their ability to follow traditional practices designed to treat illness and maintain health (Feierman 1979)—for example, to stay at home after intake of 'hot' medicines, to avoid hard work in agriculture fields during the hottest hours of the day, or certain foods in some situations.

Medical personnel and cosmopolitan culture despise local conceptions of health and disease, labeling the traditional ways of healing as inferior, superstitious and backward. In fact, traditional therapeutic means are challenged: intensification of exchanges with national society has introduced new health problems and situations they can not cope with. For instance, the resident physician reported that many patients he takes care of, especially women, presented symptoms and complaints typical of stress. According to him, many of them were anxious about their children's future, in view of new problems brought about by the ongoing socioeconomic changes in the area, exposure of youths to illegal drugs, prostitution, and so on.

So this opportunistic strategy may be due to a feeling of unease about the effectiveness of the therapeutic options available to people, be they traditional or modern, which mirrors in fact their present sociocultural situation.

In this changing sociocultural context, medicinal plants are widely used and *benzedores* are often consulted. In an illness event, like the one described above, they work to reinforce family and communal ties. Knowledge about plants and other therapies is shared and taught through advice and prescription of folk recipes for the diseased person.

It is possible that current socioeconomic changes will cause knowledge and use of medicinal plants to decrease in the studied communities for two reasons. First, younger people are becoming increasingly involved in occupations other than those of their parents. They either engage in local wage labor—agriculture, construction, or services—or migrate to Cuiabá, so at least part of the time they do not participate in the sphere of communal life where traditional knowledge is passed on. Second, land tenure and use in the area is rapidly changing. *Cerrado* vegetation has many species valued in folk medicine, but *cerrado* tracts, which were formerly common property, are now privately owned by foreigners. This places severe restrictions on their use by local people; moreover, natural areas are being replaced by cattle ranches and weekend houses.

CONCLUSIONS

Medicinal plant use in Santo Antonio is still an important and living tradition. Nevertheless, easy access to modern medicine, disruption of traditional knowledge transmission and change in land use, with destruction of natural vegetation, will ultimately lead to an erosion in both plant species availability and knowledge about them. Though people will probably continue to use medicinal plants, these will be more and more restricted to cultivated and exotic species, as is already the case for rural areas in more industrialized regions of the country.

These trends are difficult to reverse, but there are measures that could mitigate their outcomes. For example, adoption by local official health services of native medicinal plants of known therapeutic efficacy together with measures to conserve *cerrado* patches and the cultivation of some of these species could contribute to maintain this rich lore and, eventually, achieve a better integration of the various ways of treating illnesses in the area.

NOTES

[1] Voucher specimens are deposited in Herbarium Rioclarense (HRCB).

[2] *Tenda* and Medicine in the city categories were excluded from statistical tests because of great number of cells with zero.

[3] These generally comprise analgesics, antipyretics, drops against blocked nose, but may also include medicines to be used strictly with medical attendance, due to lack of control of sales and employment of medicines.

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APPENDIX 1.—Plant species present in the household/used the last six months. VN = voucher number; it refers either to herbarium (HRCB) or collector number (CA = M.C. Amorozo; MC = M. Carvalho); n.i. = not identified; i.l. = identified, but not collected; LF = life form; tre = tree; srb = schrub; sbt = shrublet; hrb = herb; epf = epiphyte; vin = vine; hpar = hemiparasite; # = purchased; c = cultivated; s = spontaneous; * = most common species; *cerrado* = Brazilian savannah.

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
ACANTHACEAE					
Justicia cf. *pectoralis* Jacq.*	anador, anador-de-planta, aspirina	CA277	hrb	homegarden	c
ALISMATACEAE					
Echinodorus sp.	chapéu-de-couro	CA310	hrb	swamp	s
ALLIACEAE					
Allium sativum L.	alho	i.l.	hrb	cultivated field in river bank	c
AMARANTHACEAE					
Alternanthera brasiliana (L.) Kuntze	terramicina	30790	hrb	homegarden	c
ANACARDIACEAE					
Anacardium occidentale L.	caju	i.l.	tre	homegarden	c
Mangifera indica L.	manga, mangueira	i.l.	tre	homegarden	c
APIACEAE					
Pimpinella sp.	erva-doce	—	hrb	#	—
APOCYNACEAE					
Catharanthus roseus (L.) Don.	bom-dia	30791	hrb	garden	c
Hancornia speciosa Gomez	mangabeira-mansa	30805	tre	*cerrado*	s
ARACEAE					
Dieffenbachia sp.	comigo-ninguém-pode	i.l.	hrb	garden, homegarden	c
ARECACEAE					
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	boucaiuveira	i.l.	tre	*cerrado*	s

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
ASTERACEAE					
Acanthospermum hispidum DC.	cabeça-de-garrotinho	30707/30709	hrb	homegarden, weedy	s
Artemisia absinthium L.	losna, novônica-macho, noz-vômica	CA432/CA313	hrb	homegarden	c
Artemisia verlotorum Lamotte	artemije	30664	hrb	homegarden	c
Bidens pilosa L.	picão-preto	30838/30839	hrb	homegarden	s
Dendrathema grandifolia (Ram.) Tzv.	camomila-branca, camomila-amarela	30677	hrb	homegarden	c
n.i.	camomila		hrb	homegarden	c
Vernonia brasiliana Druce	assa-peixe	30705	srb	fallow	s
Vernonia condensata Baker*	boldo, bordo, sara-tudo, cura-tudo	30830/30840	tre	homegarden	c
BIGNONIACEAE					
Crescentia cujete L.	cabaça	CA409	tre	homegarden	c
Cybistax antisyphilitica (Mart.) Mart.	pé-de-anta	MC5	srb	*cerrado*, homegarden	s/c
Tabebuia aurea (Manso) B. et H.	paratudo	30755	tre	*cerrado*, homegarden	s
BIXACEAE					
Bixa orellana L.	urucum	i.l.	tre	homegarden	c
BORAGINACEAE					
Cordia insignis Cham.	calção-de-velho	30747	srb	*cerrado*	s
CACTACEAE					
Pereskia cf. *grandifolia* Haworth	ora-pronobis	CA417	tre	homegarden	c
CAESALPINIACEAE					
Bauhinia sp.	pé-de-boi, unha-de-boi	30851	tre	*cerrado*	s
Chamaecrista desvauxii (Collad.) Killip	sene	30766	sbt	*cerrado*	s
Hymenaea courbaril L. var. *stilbocarpa*	jatobá-mirim, jatobá	CA289	tre	*cerrado*	s
Senna occidentalis (L.) Link	fedegoso	30849	sbt	fallow	s
Tamarindus indica L.	tamarindo, tamarino	30763	tre	homegarden	s

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
CAPRIFOLIACEAE					
Sambucus australis C. et S.	sabugueiro	30760	srb	homegarden	c
CARICACEAE					
Carica papaya L.	mamão, mamão-macho	i.l.	tre	cultivated field, homegarden	c
CARYOCARACEAE					
Caryocar brasiliense Camb.	pequizeiro, picueiro	30666	tre	*cerrado*	s
CECROPIACEAE					
Cecropia pachystachya Trec.	embaúba	30681	tre	homegarden	s
CHENOPODIACEAE					
Chenopodium ambrosioides L.	erva-de-santa-maria, santa-maria	i.l.	hrb	homegarden	s
CONVOLVULACEAE					
Ipomoea batatas (L.) Lam.	batata-doce	i.l.	hrb	cultivated field	c
COSTACEAE					
Costus arabicus L.	cana-de-macaco, caninha-de-macaco	CA44	hrb	homegarden	s/c
CUCURBITACEAE					
Luffa sp.	buchinha, buchinha-paulista	i.l.	vin	#	
Momordica charantia L.	são-caetano, melão-de-são-caetano	30820	vin	homegarden, fallow	s
DILLENIACEAE					
Curatella americana L.	lixeira	30808	tre	*cerrado*	s
EUPHORBIACEAE					
Chamaesyce caecorum (Boiss.) Croizat	sete-sangrias	30803	hrb	*cerrado*	s

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
Jatropha gossypiifolia L.	pinhão-roxo	30797	srb	homegarden	c
n.i.	quebra-pedra		hrb	cultivated field	s
Phyllanthus orbiculatus L.C. Rich	quebra-pedra	30811	hrb	*cerrado*	s
Phyllanthus stipulatus (Raf.) Webster	quebra-pedra	CA405	hrb	homegarden	s
Ricinus communis L.	mamona, óleo-de-rícino	30798/30800	srb	homegarden	s
FABACEAE					
Acosmium dasycarpum (Vog.) Yakovl.	genciana, quina-genciana	CA294	srb	*cerrado*	s
Cajanus cajan (L.) Millsp.	feijão-andu	CA355	srb	homegarden	c
Dipteryx alata Vog.	cumbaru	30813	tre	*cerrado*	s
cf. *Eriosema campestre* Benth.	bácimo	30852	hrb	*cerrado*	s
Machaerium aculeatum Raddi*	espinheira, espinheiro	CA269	tre	swamp	s
FLACOURTIACEAE					
Casearia sylvestris Sw.	chá-de-frade	CA5	srb/tre	*cerrado*	s
LAMIACEAE					
Coleus sp.*	boldo, bordo	i.l.	srb	homegarden	c
Cunila microcephala Benth.	poejo, apoejo	30687	hrb	homegarden	c
Hyptis crenata Pohl. ex Benth./*Hyptis goyazensis* St.Hil. ex Benth.*	hortelã-do-campo, hortelã-da-vargem	30842/30674	sbt	*cerrado*	s
Hyptis suaveolens Poir.	tapera-velha	30688	hrb	fallow, ruderal	s
Leonotis nepetaefolia (L.) R. Brown	cordão-de-são-francisco	30689	hrb	homegarden, weedy	s
Mentha arvensis L. var. *piperascens* Malinv.	vick	30671/30675	hrb	homegarden	c
Mentha sp.	hortelãzinho, hortelã	30672	hrb	homegarden	c
Ocimum gratissimum L.	alfavaca	30822/30823	sbt	homegarden	c
n.i.	hortelã-gordo	CA422	hrb	homegarden	c
LAURACEAE					
Persea americana Mill.	abacate	i.l.	tre	homegarden	c
LILIACEAE					
Sansevieria sp.	espada-de-são-jorge	i.l.	hrb	garden, homegarden	c
LOGANIACEAE					
Strychnos pseudoquina St. Hil.	quina	CA251	tre	*cerrado*	s

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
LORANTHACEAE					
Psittacanthus calyculatus (DC.) C. Don	enxerto-de-passarinho	30826	hpar	homegarden, wetlands	s
Psittacanthus sp.	enxerto-de-passarinho	CA448		homegarden, wetlands	s
LYTHRACEAE					
Lafoensia cf. *replicata* Pohl.	mangabeira-braba	MC48	tre	*cerrado*	s
MALPIGHIACEAE					
Camarea ericoides St.Hil.	arnica	30668	hrb	*cerrado*	s
Heteropterys pannosa Griseb.	nó-de-cachorro, raiz-de-santo-antonio	MC3	sbt	*cerrado*	s
Malpighia glabra Linn.	acerola	i.l.	srb	homegarden	c
MALVACEAE					
Abutilon sp. 1	marva, mave	30738/30739	hrb	homegarden	s/c
Abutilon sp. 2	mave	30737	hrb	homegarden	s/c
Gossypium barbadense L.*	algodão, algodão-de-casa	30735	srb	homegarden	c
Sida sp.	sem nome (no name)	i.l.	hrb	homegarden	s
MELASTOMATACEAE					
Tibouchina cf. *clavata* (Pers.) Wurd.	cibalena	CA445	srb	homegarden	c
MIMOSACEAE					
Stryphnodendron adstringens (Mart.) Coville	barbatimão	CA264	tre	*cerrado*	s
MONIMIACEAE					
Siparuna guianensis Aubl	negra-mina	30740	tre	*cerrado*	s
MORACEAE					
Brosimum gaudichaudii Tréc.	algodãozinho	CA441	tre	*cerrado*	s
Dorstenia asaroides Gardner	caiapiá	CA7	hrb	cultivated field, *cerrado*	s
MUSACEAE					
Musa × *paradisiaca* L.	bananinha, bananeira	i.l.	hrb	cultivated field, homegarden	c

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
MYRTACEAE					
Eucalyptus sp.*	eucalipto	CA308	tre	street	c
Eugenia uniflora L.	pitanga	CA377	tre	homegarden	c
Psidium guajava L.	goiaba, goiabeira, goiaba-branca	i.l.	tre	homegarden, cultivated field	c
Syzygium cumini (L.) Skeels	jambo	CA431	tre	homegarden	c
OXALIDACEAE					
Averrhoa carambola L.	carambola	30700	tre	homegarden	c
PASSIFLORACEAE					
Passiflora edulis Sims	maracujá	i.l.	vin	homegarden	c
PHYTOLACCACEAE					
Petiveria alliacea L.*	guiné	30685	hrb	homegarden	c
PIPERACEAE					
Piper tuberculatum Jacq.	jaborandi, jaguarandi	30669/30670	srb	*cerrado*, homegarden	s
POACEAE					
Coix lacryma-jobi L.	conta-de-nosso-senhor, erva-de-santa-maria	30711	hrb	homegarden	c
Cymbopogon citratus Stapf.*	capim-cidreira	CA300	hrb	homegarden	c
Saccharum officinarum L.	cana-de-açúcar	i.l.	hrb	cultivated field	c
Vetiveria zizanioides (L.) Nash	capim-santo	30710	hrb	homegarden	c
POLYGONACEAE					
Polygonum hydropiperoides Michx.*	erva-de-bicho	30686	hrb	swamp	s
PUNICACEAE					
Punica granatum L.*	romã	i.l.	tre	homegarden	c
RUBIACEAE					
Rudgea viburnoides (Cham.) Benth.	douradinha, erva-mulá	30742/30782	srb	*cerrado*	s

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
RUTACEAE					
Citrus sp. 1	lima-de-umbigo	CA341	tre	homegarden	c
Citrus sp. 2	lima-das-peças	CA343	tre	homegarden	c
Citrus × *aurantiifolia* (Christm.) Swingle/*Citrus* × *limon* (L.) Osbeck	limão-galego, limão, limão-taiti	CA291/CA339/CA344	tre	homegarden	c
Citrus × *aurantium* L.*	laranja	CA340/CA342	tre	homegarden	c
Ruta graveolens L.*	arruda	i.l.	hrb	homegarden	c
SCROPHULARIACEAE					
Scoparia dulcis L.	vassourinha	30727/30728	hrb	homegarden	s
SIMAROUBACEAE					
Simaba trichilioides St.Hil.	calunga	30722	sbt	*cerrado*	s
SOLANACEAE					
Solanum cf. *comptum* Morton	joá	30719	sbt	*cerrado*, swamp	s
n.i.	beladona	CA433	srb	homegarden	c
STERCULIACEAE					
Guazuma sp.	chico-magro	30726/30720	tre	*cerrado*, homegarden	s
VERBENACEAE					
Lantana camara L.	cambará	30691	sbt	fallow	s
Lippia alba (Mill.) N.E.Br.*	erva-cidreira, cidreira-de-rama	CA407/CA408	sbt	homegarden	c
Stachytarpheta cayenensis (L.C. Rich.) Vahl.*	gerbão, gervão	MC2	sbt	homegarden	s
VOCHYSIACEAE					
Vochysia divergens Pohl.	cambará	30846	tre	*cerrado*, near swamp	s
ZINGIBERACEAE					
Alpinia zerumbet (Pers.) Burtt & Smith	colonia	30693	hrb	homegarden	c

APPENDIX 1—(continued)

FAMILY/Species	Vernacular name	VN	LF	Habitat/occurrence	C/S
INDETERMINATE					
1.	babosa	—	hrb		c
2.	cravo	—	tre		c
3.	cancerosa	—	—		c
4.	douradinho	—	—		—
5.	espada-de-nossa-senhora	—	hrb		c
6.	jacarandá	—	tre		s
7.	jequitibá	—	tre		s
8.	quina-do-morro	—	tre?		—

BOOK REVIEWS

DARRON A. COLLINS
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Food in the Ancient World from A to Z. Andrew Dalby. 2003. Routledge, London and New York. Pp. xvi + 408. $65.00 (hardcover). ISBN 0-415-23259-7.

Andrew Dalby has rapidly carved a name for himself as *the* expert on the ethnobiology of ancient Greece and Rome, and one of the leading experts on food during that period. Here he assembles a monumental amount of scholarship into a dictionary that will be a basic reference for a long time to come. This is the sort of book that one expects to see being produced by a whole team of senior scholars; to have such a work produced by one relatively young scholar is nothing short of incredible. Compiling such a dictionary for the Maya peoples, for example, would be hard enough; think of the task when one has to deal with thousands of original sources (ranging from vast books to scattered papyri and ostraca) and tens of thousands of secondary sources. Yet Dalby wears his knowledge lightly. He has made the entries notably readable, with wry and humorous asides in many cases. Sometimes these are his own; more often they are quotes or tags from the classic comic writers.

The entries cover foodstuffs, including those rare and exotic; ancient food writers and medical authorities, again including even the most obscure; and places noted for their food and wine. Dalby is very conscious of the enormous importance of that latter commodity in ancient civilization and has long and thorough entries on all aspects of wine culture, from manufacturing techniques to famous vintages.

Research in ancient-world ethnobiology has made great progress lately, thanks to archaeology and to scholarship such as Alan Davidson's work on Mediterranean seafood, but Dalby still had to sort through and evaluate a vast amount of nonsense, including early guesses at identification of species. He also has to tread lightly around some still-fiery controversies, such as the one over spices in the ancient world. J. I. Miller's *Spice Trade of the Roman Empire* (1969) assumed that cinnamon, cardamom, pepper, and the like were flowing into Rome in vast amounts. This position was sharply attacked by Patricia Crone in *Meccan Trade and the Rise of Islam* (1987); Crone held that words like *kinnamon* and *kardamomon* referred originally to local Mediterranean plants, being transferred only very late to Asian commodities, and that the spice trade never amounted to much. Dalby follows recent archaeological findings in taking a cautious middle ground, somewhat closer to Miller. Readers may wish he had said more about the issue, but his handling of it is delicate and sensible.

"Even Homer nodded," as the ancients said, and there are mistakes in this book. Most are trivial errors in nomenclature. Significantly, *Gallus gallus* is labeled as "*Gallus gallinaceus*" on page 83. On page 169, the hazel hen is called a "sandgrouse," which it is not. More serious is the entry on the banana (p. 44): "fruit of a palm domesticated in New Guinea. . . ." The banana is, of course, not a palm, and only a rather obscure species (*Musa fehi* CLG Bertero ex E. (DE) Vieillard) was domesticated in New Guinea. The common banana (*Musa* x *paradisiaca*) is an artificially created hybrid probably "stemming" from Malaysia. No doubt an expert in the classics would find more errors than I have, but at the very least this is a notably reliable work.

Archaeobiologists will find this book particularly useful. The archaeological information is reasonably up-to-date, though not always. (*Panicum* millet is said to have been domesticated in the Caucasus, p. 218; most recent evidence supports China as the source, but the question is still very open.) Archaeologists will want to supplement Dalby's book with site reports.

Ethnobiologists frequently need references on the ancient world, if only because students and the public are often aware of, and very interested in, ancient Greece and Rome. This is clearly the reference of choice, and is a very worthwhile book to add to one's library.

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Discerning Palates of the Past: An Ethnoarchaeological Study of Crop Cultivation and Plant Usage in India. Seetha Narahari Reddy. 2003. Ethnoarchaeological Series 5. International Monographs in Prehistory, Ann Arbor, Michigan. Pp. xi + 175; photographs, glossary. $65.00 (hardcover), ISBN 1-879621-37-1. $47.50 (paper), ISBN 1-879621-36-3.

It is a pleasure to read a well-written book that so masterfully welds together archaeology and ethnography about human and animal plant use. The focus of this volume is millets, Harappan sites in the state of Gujarat in western India, and the complementary interactions between pastoralism and agriculture. Although ethnoarchaeological modeling of crop processing for archaeological application premiered with the outstanding studies on wheat and barley by Hillman and Jones in the 1980s, nowhere before has anyone looked at millets. Millets are relatively small-seeded annuals with growth habits that range from strong-stalked, compact-headed inflorescences (Type A crops) to multiple weaker stalks with looser panicles (Type B crops). Domesticated millets originated in southern and eastern Asia as well as Africa, and wild millets are found just about worldwide. I believe Reddy's observations on millets have general application for archaeological assemblages that include small-seeded annual grasses.

Reddy blends together three lines of evidence: her ethnographic study of crop cultivation and processing in India, the paleoethnobotanical record from two Harappan sites, and carbon isotope studies of dirt and cattle bones from these two sites (millets are C4 plants, whereas most of the associated weeds in the area are C3). Her goal is to model the interplay of crop processing with end product use (e.g., human food, animal fodder, or both) to aid in the interpretation of archaeological evidence.

Reddy's ethnographic observations focused on intensive summer monsoon cultivation of Type A crops (*Pennisetum typhoides* (Burm. f.) Stapf & C.E. Hubb. and *Sorghum bicolor* (L.) Moench) in Gujarat in western India, and extensive winter riverbank opportunistic cultivation of the Type B crop *Panicum miliare* Lam. in Andhra Pradesh in southeastern India. Whereas Type A, thick-stalked and compact-headed crops (*P. typhoides, S. bicolor,* and *Eleusine coracana* Gaertn.) are harvested one to three stalks at a time, a strategy that selects against inclusion of weeds, weeds are frequently included in the group harvest of Type B thin-stalked crops (e.g., *P. miliare* and *Setaria* spp.). Other factors that contribute to the inclusion or exclusion of weeds at harvest include the habit of the weed (prostrate vs. erect) and, of course, whether the weed ripens at the same time as the crop. Reddy presents an interesting twist by pointing out that even Type B crops can be harvested weed-free when, as in her case study in Andhra Pradesh, the weeds are prostrate and below the level at which the crop stalks were cut for harvest. Whereas the previous models by Hillman (1984) and Jones (1987) of when and how weed seeds may be processed out of a crop focused on the three weed characteristics of winnowability (ratio of seed surface area to weight), sievability (seed size), and seed headedness, Reddy found the interplay of seed size (small vs. big), headedness (a continuum from free to headed), and weight/aerodynamics (a combination of seed weight, shape, and aerodynamic appendages) to be more germane to the crop-processing strategies. By concentrating on the properties of the weed seeds themselves, separate from any specific crops or "stages" of crop processing, Reddy provides a model that is transferable for use with other crop types. Her handling of multiple combinations of crop/weed characteristics or harvest/processing/use choices is skillful, leading the reader through a labyrinth of possibilities rather than presenting an oversimplification of human behavior that marks too many archaeological studies.

Not only were crops represented by their end use (e.g., as human food, animal fodder, or both), but also as byproducts that could contribute to animal fodder. Products and byproducts may be used green, fresh, or dry; they may be stored or not at various points along the processing continuum; and, likewise, are suitable or not for trade or exchange. Choices made about the location of each of the processing steps affects the likelihood of exposure to fire (resulting in preservation) or the likelihood of even finding that location for archaeological study. In Chapter 4, Reddy supplies illustrated chart models for what products, byproducts, and archaeological findings may be expected at each step along the way of processing either a Type A (thick-stalked, single-headed) or Type B (thin-stalked, loose panicle) crop. Incidentally, she points out that *Chenopodium album* L. is processed as a Type B crop in India: *Chenopodium* is another widespread genus frequently consumed by humans or supplied to animals as fodder. To round out her understanding of implications for archaeological interpretation, Reddy conducted experimental charring of millets to investigate the likelihood that seed stalks could be preserved.

What is used for animal fodder may depend on the season or ripeness (green vs. dry), and certainly reflects preferences by species (e.g., whether it enhances milk production or not). Archaeologically, plants used for animal fodder may be represented both in dung (used as fuel or as plaster) and in the isotopic ratios in animal bone. Reddy briefly reports on her pilot study of dung and hearth samples at two archaeological sites in Gujarat. Additionally, she analyzed a total of nine sediment samples from the two sites and 22 cattle bones for an indication of C3 vs. C4 plants. She found that the general background vegetation at both sites yielded C3 soil, as expected. The analysis of cattle bones, however, was mostly unsuccessful and the results inconclusive. In Chapter 7 Reddy models animal feeding for domesticated herbivores such as cattle, pigs, sheep, and goats.

Reddy then applies her models to the two sites—Babar Kot, a very late Mature Harappan site dating to 2200–2050 B.C., and Oriyo Timbo, a Late Harappan site dating to 1900–1800 B.C. She makes a strong argument that Babar Kot was a substantial settlement practicing year-round sedentary agriculture focused on summer and winter crops of millets, legumes, and oilseeds and on animal husbandry. Millets were grown for human consumption. Although millet byproducts likely were used for fodder, she could not prove it. Oriyo Timbo, on the other hand, represents a seasonal settlement used by seminomadic or semisedentary pastoralists who may or may not have been growing their own millet. However, they certainly were bringing highly processed millet to that location for human consumption. Both sites reflect the complementarity of agriculture and pastoralism in the Harappan sphere of influence.

I highly recommend this book—to archaeologists working in Africa or Asia; to ethnographers working with agricultural or pastoral societies; to paleoethnobotanists who work with small-seeded annual crops or weeds; to social scientists who study agriculture and pastoralism; and to students of ethnoarchaeology. It is a well-written, outstanding example of how ethnographic studies may enhance archaeological interpretation. The text lays out a very complex web of interrelationships and weaves them together to present one of the most realistic reconstructions I have seen of the complex daily decisions that had to be made in the past. I warn readers that the models with drawings can only be appreciated by reading the text. The volume is nearly free of printing/editing errors, and I was puzzled by only one statement by the author, classifying *Brassica* (mustard) as a legume (pp. 113, 122, and 128).

My original interest in this volume was sparked because it reported on Oriyo Timbo, a site where I worked in 1981–1982 (Reddy reports on the 1989–1990 season). During 1982–1983 excavations at nearby Rojdi, I observed seasonal cultivation of a river bottom when drought reduced the river to scattered puddles and pools. What struck me most at the time was that what had been a large, seemingly permanent river the year before was now a naked river bed. What strikes me now is that Reddy has provided a model for how even such ephemeral cultivation practices may be reflected in the archaeological record.

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Nature, Culture, and Big Old Trees: Live Oaks and Ceibas in the Landscapes of Louisiana and Guatemala. Kit Anderson. 2003. University of Texas Press, Austin. Pp. 183 + photographs. $19.95 (paper). ISBN 0-292-70212-4.

Anyone interested in big trees who has visited Tikal in the Guatemalan Petén will immediately recognize the towering ceiba (*Ceiba pentandra* (L.) Gaertn.) on the book's front cover. Loving big trees and having conducted ethnobotanical research in Guatemala as a graduate student at Tulane (in New Orleans), I was initially drawn to the book by those associations. I became curious almost immediately: why *these* species and not others; what kind of conclusions could the author possibly draw; will the book be theoretically useful or "just" a good read?

The book is divided into five chapters and neither the first nor the second chapter did much to satisfy my curiosity. Chapter One, Introduction: Human Tree Relationships, served its purpose in detailing where the text would go, summarized nicely how big trees have shaped human imagination, and outlined how trees might shed some light on the trajectory of culture. Chapter Two, Dances with Trees: Notes from the Field, is an amalgam of stories from the author's fieldwork in the two locales. The black and white photographs are many and quite excellent, as are many of the stories. However, I finished reading the chapter feeling that the descriptions were somewhat shallow and anecdotal, especially on the side of the Guatemalan ceiba. The chapter's concluding section, Patterns and Questions, did not answer the question that kept coming to me: "Where is this going to go?"

Chapter Three, Natural History: The Secret Lives of Ceibas and Live Oaks, is very well done. The botany, ecology, and natural history was a real pleasure to read—very accurate, detailed, and nicely written. The comparative maps and associated discussions documenting the "natural" versus the "cultural" distributions of the two trees were very revealing and insightful. As in previous chapters, the photographs were excellent, telling, and perfectly parallel with the text. Human behaviors that have affected the distribution of the trees were elucidated and the *meaning* of the text and the reason for its authorship started to emerge.

Chapter Four, Cultural History: How Trees Develop Character, was also excellent. Again, the information on the Louisiana live oaks (*Quercus virginiana* P. Mill.) was more detailed. The ceiba received approximately 16 pages of text and the live oaks about 26. Nevertheless, the discussion on the cultural associations of the live oaks was wonderful in terms of detail, breadth, and writing. And it was in this chapter and especially in the chapter's closing section where the two trees' similar "role" in the cultural context was highlighted: "Within the cultural landscape, live oaks and ceibas occupy some remarkably similar niches." That in itself may not be very remarkable, but the degree and extent to which this is true is quite extraordinary. The discussion on the control that land tenure, town structure, and architectural style exerts on the life histories of these trees is very engaging. But the final chapter, Coda: Charismatic Megaflora and the Making of Landscapes, would be the one that would decide whether or not the text would come to any striking or at least significant conclusions.

On page 154 of the final chapter the author admits, "Sweeping generalizations concerning cultural attitudes toward these big trees are pointless, I found." Nevertheless, by her examination of these fantastic trees, Anderson uncovers some interesting, generalizing points: trees are not passive but active participants in the creation of landscapes; trees acquire symbolic meaning over time; individual humans, through tree planting and care, can play an enormous role in the transformation of landscapes; and, certain trees achieve favored status in particular ways. These insights are valuable. They also help answer some of my concerns relating to the book's purpose. Simply stated, the two trees share many of these characteristics listed above in common—they play a similar "role" in relation to humans. But these characteristics were discovered *post facto* and do not clarify why such comparative investigations were initiated. Also, the chapter's penultimate section, "Nature and Culture," does not treat this widely discussed dichotomy with enough detail. The wealth of information on historical ecology, which could shed significant light on the question, generally speaking and where these two trees are concerned, is not addressed.

Anyone who loves trees and loves to think about the meaning of trees should absolutely consult Anderson's text. The book is informative, very well written, replete with many superb photos, and reaches some interesting conclusions. As for my first question: even though I still do not fully understand the author's decision to write about ceiba and live oak, and the book left me wanting more detail and analysis, its many charms compensate for these criticisms.

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What Place for Hunter-Gatherers in Millennium Three? Thomas N. Headland and Doris E. Blood (eds.) 2002. SIL International and International Museum of Cultures Publications in Ethnography 39. Dallas, Texas. Pp. 129. $19.00 (paper) ISBN 1-55671-132-8.

This edited volume considers the plight and survival prospects of the Agta hunter-gatherers of the Philippines. It also asks whether any hunter-gatherers will remain intact as autonomous ethnic groups through the twenty-first century. The volume contains seven contributed chapters, photographic documentation of the Agta during the past thirty years, and a complete bibliography of all publicly available published works on the Agta. The contributed chapters discuss the current situation of the San groups of Southern Africa, the forager-farmer symbiotic groups of the Congo Basin, the Negritos of Southeast Asia, and a detailed examination of deforestation in the Philippines. In general what we learn is that all these groups are facing bleak prospects for continued survival as independent ethnic entities, and that environmental destruction is a major factor in their demise.

The first chapter by Hitchcock describes the battle of San peoples for land against a tidal wave of ranching expansion, the struggle for resource use rights in the face of restrictive park regulations and tourism priorities, and a battle for dignity and self-determination in the face of bald racism by both Blacks and Whites who consider the San to be a "natural" servant class. The second chapter by Bailey provides demographic documentation of a threatened population of Efe foragers in the Central African rainforests. The Efe show extremely low fertility due to seasonal food shortages and sexually transmitted diseases. They are also culturally oppressed by more politically and economically powerful neighbors and, because of high rates of hypergyny (Efe women marrying outside men), the group is in danger of both genetic and cultural extinction. High rates of deforestation and land invasion are the greatest and most immediate threats to the Efe people.

The remainder of the volume examines the case of the Agta people in the Philippines. The Agta have lost most of their land—and access to natural resources necessary for their survival—and have become victims of economic exploitation, modern infectious diseases, and a loss of hope and self-esteem. Such problems lead to alcoholism, depression, and hypergynous mating between Agta women and higher status outsiders, destroying the will to live and the drive to succeed for many Agta men. The situation of the foraging societies described in this volume mirrors the threats faced by many small-scale tribal societies and minority ethic groups around the world.

The detailed examination of the Agta case is illustrative of a larger historic process of conquest and assimilation or elimination of the "Negrito" peoples in Southeast Asia over the past few millennia including alarming yearly reports about the near extermination of the natives of the Andaman Islands. This sad portrayal of the plight of the Philippine Negritos has been foreshadowed by books such as Eder's *On the Road to Tribal Extinction* (1992) and Early and Headland's *Population Dynamics of a Philippine Rainforest People* (1998).

Racism and ruthless silent conquest are the two processes underlying this historic displacement, and all indications suggest that both African groups discussed in the text are experiencing many of the same problems as the Agta. Indeed, I have seen the same processes among tribal societies in the Amazon forests where I have worked for nearly thirty years. Darcy Ribeiro documented forty years ago that nearly half of all native tribes in Brazil that were known at the beginning of the twentieth century were extinct by 1950. In some cases such as the Agta, Amazonian tribes, the Penan of Borneo, and the Central African forest peoples, timber and mining interests along with rampant deforestation and rapid colonization have been to blame. But a larger worldview suggests that deforestation alone is not the cause of tribal extermination. Indeed there is no valuable timber to be had in the Kalahari desert, or in the Paraguayan Chaco (where hunter-gatherer groups have experienced the same ethnic destruction as reported for the Agta), nor in Tierra del Fuego, where the Ona were exterminated within fifty years of their first peaceful contact with Europeans. Instead, pure unadulterated conquest of territory has led to the recent demise of hunter-gather populations just as it led to the near extermination of California natives in the nineteenth century.

The battle for tribal survival is a human rights battle. Groups that should be allies must be persuaded that natives share with them mutual interests. Because habitat destruction is often a root cause of tribal destruction, conservation organizations sometimes lend valuable support to native peoples. But almost as often conservationists have been behind the movement to forcibly remove native peoples from their traditional territories in order to set up "people-free" parks and reserves that support a cadre of outside biologists and tourism enterprises but leave native peoples on the fringes of their ancestral lands, as beggars and cheap labor for the "foreign" enterprises. The U.S. led the way in this process eliminating all native resource use rights in National Parks and public lands as they were created over the past two centuries. A similar disenfranchisement of native peoples has been standard fare in Africa, Asia, and South America. Arrangements that allow native peoples resource use rights, such as in the Okopi Wildlife Refuge described in Bailey's chapter, must emerge as the standard arrangement between natives and conservationists. Conservationists would do well to read this book, which highlights some the difficult decisions to be faced when considering whether to prioritize "nature" conservation over "culture" conservation.

There is no empty natural habitat in the world (unless the native group that once lived there has been recently exterminated) and there hasn't been for many thousands of years. Because most native groups cannot and do not desire to rapidly make the transition to a "developed" economy, they are excellent guardians of natural habitat. They need natural resources to survive, and thus have a stake in the preservation of natural habitat. If international conservation organizations would recognize this fact and fully incorporate it into their long-term agenda, both hunter-gatherers and the wild resources that sustain them would face a much-improved prospect for survival in the third millennium.

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Plant Resins: Chemistry, Evolution, Ecology, and Ethnobotany. Jean H. Langenheim. 2003. Timber Press, Portland, Oregon. Pp. 586 + illus. $49.95 (hardcover). ISBN 0-881925-748.

Jean H. Langenheim's text seems certain to become the most widely read and cited book about plant resins for many years to come. Dr. Langenheim is professor emeritus of biology and a research professor at the University of California, Santa Cruz and has been one of the most eminent researchers in the field of plant resins for over 40 years. This work finally replaces *Vegetable Gums and Resins* (1949) by Frank N. Howes as the most up-to-date and comprehensive treatment of this subject.

This ambitious book presents an integrated view of plant resins that includes their formation, composition, defensive functions for the plants, and their importance to the many insects and mammals (including people) that use them. The first of the book's three parts covers plant resin production with chapters emphasizing the definition and chemistry of different resin types, an overview of the evolution of resin-producing plants, and a description of the structures plants use to secrete and store resin. Part II covers the geological history and ecology of resins. Its chapters describe the knowledge and mysteries of amber (fossil resin) and the interactions between plants, herbivores, and resins.

The third section of *Plant Resins* covers resin ethnobotany, with chapters explaining the past importance and future use of resins. One overview chapter within Part III provides fascinating accounts of the importance of amber and resins to people from the Stone Age to the present. The chapter illuminates the numerous times throughout history that procuring and trading resins have had profound impacts on cultures and economies across the globe, especially in the case of amber and various incenses. Later, more specific chapters detail the origins and uses of three major classes of resins—oleoresins, fragrant and medicinal balsams, and varnish and lacquer resins. The best chapters make connections between the history of resin use with the biological aspects of the resin source and formation. Some examples, however, do not have the same level of well-roundedness, but do provide the basic facts about all of the common and many of the obscure resins found throughout the world.

One of the book's simplest and most important contributions is in providing clear definitions of what plant resins and their subcategories are and, just as important, what they are not. These definitions give readers a solid foundation for understanding the many facets of this book and in helping sort through other works that may use ambiguous or inaccurate meanings about resins and other plant exudates. For example, Langenheim points out (p. 27) that the trade term "essential oil," which refers to volatile terpenes in some plants, is misleading out of the industry context because these compounds are "neither essential to plant metabolism nor are they true oils; essential refers to their essence or fragrance, and oil to their feel." The clear descriptions of the basic classes of terpenoid and phenolic resins are particularly helpful for nonchemists, because they help explain how differences in resin composition influence the degree to which a resin remains fluid or hardens after exposure to air, a key property that affects its ecological function and/or human use.

Any ethnobiologist who has encountered plant resin use by people will gain a deeper appreciation for resins by learning about them through the eyes and efforts of diverse investigators cited in this book. *Plant Resins* provides a vivid example of the way ethnobiology can advance as an interdisciplinary field by synthesizing information and insights from chemists, ecologists, and anthropologists. The author writes about each subject area with clarity, confidence, and precision. The glossary will help readers with no scientific background to easily understand most of the information and concepts in the book. Dr. Langenheim draws heavily on her own extensive work and brilliantly connects the salient points from hundreds of other researchers in the field. When she believes other researchers' conclusions are not supported by solid evidence, however, she does not accept their views without reservation.

On a slightly critical note, each paragraph contains numerous references, although every phrase does not have a corresponding citation. This format makes the text more readable than scientific journals, but sometimes leaves the reader wanting to know the specific source of a particular point. The meticulous illustrations including maps, plant and plant parts, chemical structures, and flow charts complement the text well. The color and black and white photographs bring to life the processes relating to resin formation and harvest.

Dr. Langenheim's prowess as a scholar has allowed her to bring together an impressive array of the past and current explorations about plant resins into one book. Her length and breadth of experience with the diverse aspects of this topic have also enabled her to critically analyze the information from a holistic standpoint and recommend topics that should be investigated in the future. Some of the enticing puzzles that researchers will face include elaborating resin formation processes in plants, unraveling the complex physiological and ecological resin interactions with insects, and investigating new ways that people can utilize plant resins. *Plant Resins* will become the standard reference for this subject because it brings together the many dimensions of plant resin research and will inspire the next generation of researchers to probe new resin mysteries.

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