JOURNAL STAFF

EDITOR: Eugene S. Hunn, Department of Anthropology, Box 353100, University of Washington, Seattle, WA 98195-3100 (hunn@u.washington.edu)

ASSOCIATE EDITOR (Spanish): Alejandro de Avila B., A. P. 533, Oaxaca, Oaxaca C.P. 68000, MEXICO (serbo@antequera.com)

NEWS & COMMENTS EDITOR: Gary J. Martin, People and Plants Initiative, B.P. 262, Marrakesh-Medina, MOROCCO (100427.1260@compuserve.com)

BOOK REVIEW EDITOR: Sandra Peacock, Department of Geography and School of Environmental Studies, University of Victoria, Victoria, BC V8W 2Y2 CANADA (speacock@office.geog.uvic.ca)

SOCIETY OFFICERS

PRESIDENT: Nancy J. Turner, School of Environmental Studies, University of Victoria, Victoria, BC V8W 2Y2 CANADA

PRESIDENT-ELECT: Deborah M. Pearsall, American Archaeology Division, University of Missouri, Columbia, MO 65211

SECRETARY/TREASURER: Gayle J. Fritz, Department of Anthropology, Washington University, St. Louis, MO 63130-4899

CONFERENCE COORDINATOR: Mollie S. Toll, University of New Mexico, Albuquerque, NM

BOARD OF TRUSTEES

Eugene N. Anderson, University of California, Riverside, CA
Enrique Salmón, Fort Lewis College, Durango, CO
Gail Wagner, University of South Carolina, Columbia, SC

Ex officio

Past presidents: **Steven A. Weber, Amadeo M. Rea, Elizabeth S. Wing, Paul Minnis, Cecil Brown,** and **Catherine S. Fowler.** Permanent board member **Steven D. Emslie**. The editor, president, president-elect, secretary/treasurer, and conference coordinator.

EDITORIAL BOARD

Karen R. Adams, Crow Canyon Archaeological Center, Cortez, CO: *paleoethnobotany.*
Eugene N. Anderson, University of California, Riverside, CA: *ethnobotany, China, Maya.*
Scott Atran, CNRS, Paris, FRANCE: *ethnobiological classification, cognition, history of science, Maya.*
Brent Berlin, University of Georgia, Athens, GA: *ethnobiological classification, medical ethnobotany, Maya.*
Robert A. Bye, Jr., Jardín Botánico, Universidad Nacional Autónoma de México, México, D.F., MÉXICO: *ethnobotany, Mexico.*
H. Sorayya Carr, El Cerrito, California: *zooarchaeology.*
Nina Etkin, University of Hawaii, Honolulu, HI: *medical ethnobotany, the Pacific.*
Gayle J. Fritz, Washington University, St. Louis, MO: *paleoethnobotany.*
David R. Harris, University College, London, ENGLAND: *ethnoecology, subsistence systems, archaeobotany.*
Terence E. Hays, Rhode Island College, Providence, RI: *ethnobiology, Papua New Guinea.*
Chris Healey, Northern Territory University, Darwin, AUSTRALIA: *ethnozoology, Australia and New Guinea.*
Timothy Johns, Macdonald College of McGill University, Quebec, CANADA: *chemical ecology, ethnobotany, East Africa.*
Harriet V. Kuhnlein, McGill University, Quebec, CANADA: *ethno/human nutrition, First Nations of Canada.*
Brien A. Meilleur, Center for Plant Conservation, Missouri Botanical Garden, St. Louis, MO: *ethnoecology, plant conservation, ethnobotanical gardens.*
Gary Nabhan, Arizona Sonora Desert Museum, Tucson, AZ: *ethnobiology, Sonoran desert cultures.*
Darrell A. Posey, Oxford Centre for the Environment, Ethics, and Society, Oxford University, Oxford, ENGLAND: *natural resource management, ethnoecology, tropical cultural ecology.*
Amadeo M. Rea, San Diego, CA: *cultural ecology, zooarchaeology, ethnotaxonomics.*
Elizabeth J. Reitz, University of Georgia, Athens, GA: *zooarchaeology.*
Mollie S. Toll, University of New Mexico, Albuquerque, NM: *prehistoric and historic ethnobiology.*

The *Journal of Ethnobiology* is published semi-annually. Manuscripts for publication, information for the "News and Comments" and book review sections should be sent to the appropriate editors as listed on the inside back cover of this issue.

© Society of Ethnobiology
ISSN 0278-0771

COVER ILLUSTRATION: Flores Scops-Owl (*Otus alfredi*), prototype of the Nage category *po* (see Forth's article, pp 189-209, this issue). The term ***po*** is at the center of a web of conceptual associations that link nocturnal birds, diurnal birds of prey, other 'witch birds,' and a variety of portentous sounds believed to be produced by malevolent beings. Chris Healey, editorial board member and accomplished bird artist, created this fine drawing especially for our cover.

MISSOURI BOTANICAL

MAY 1 1 1999

GARDEN LIBRARY

Journal of Ethnobiology

VOLUME 18, NUMBER 2 WINTER 1998

SOCIETY OF ETHNOBIOLOGY
23RD ANNUAL MEETING

Ann Arbor, Michigan, USA
March 29-31, April 1, 2000

Contact: Dr. Richard I Ford, Ethnobotanical Laboratory, Museum of Anthropology, University of Michigan, Ann Arbor, MI 48109-1079. Phone: (734) 936-2952. E-mail: riford@umich.edu.

CONTENTS

ETHNOBIOTICA v

AUTHOR PROFILES vi

THE HISTORICAL FOUNDATIONS OF ETHNOBIOLOGY (1860-1899)
Daniel Clément 161

THINGS THAT GO *PO* IN THE NIGHT: THE CLASSIFICATION OF BIRDS, SOUNDS, AND SPIRITS AMONG THE NAGE OF EASTERN INDONESIA
Gregory Forth 189

INTERPRETING WILD SEEDS FROM ARCHAEOLOGICAL SITES: A DUNG CHARRING EXPERIMENT FROM THE ANDES
Christine A. Hastorf and Melanie F. Wright 211

TESTING PRAIRIE PLANTS WITH ETHNOBOTANICAL IMPORTANCE FOR ANTI-CANCER AND ANTI-AIDS COMPOUNDS
Kelly Kindscher, Kirk P. Manfredi, Melissa Britton, Maria Demidova, and Dana P. Hurlburt 229

THE ROOTS OF TRADITION: SOCIAL ECOLOGY, CULTURAL GEOGRAPHY, AND MEDICINAL PLANT KNOWLEDGE IN THE OZARK-OUACHITA HIGHLANDS
Justin M. Nolan 249

PLANT FOOD RESOURCE RANKING ON THE UPPER KLAMATH RIVER OF OREGON AND CALIFORNIA: A METHODOLOGY WITH ARCHAEOLOGICAL APPLICATIONS 273
Donn L. Todt and Nan Hannon

RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS XVI
Terence E. Hays 309

BOOK REVIEWS
Siren Feasts: A History of Food and Gastronomy in Greece
by Andrew Dalby
Eugene N. Anderson 188

Ethnobotany of the Primitive Tribes in Rajasthan
by Prabhakar Joshi
Joseph E. Laferrière 210

MISSOURI BOTANICAL
MAY 11 1999
GARDEN LIBRARY

Reviews of Books on Hallucinogenic Plants by Jonathan Ott

Plantas de los Dioses: Orígenes del Uso de los Alucinógenos [Plants of the Gods: Origins of the Use of Hallucinogens]; Pflanzen der Götter: Die magischen Kräfte der Rausch- und Giftgewächse [Plants of the Gods: The Magical Powers of Toxic and Inebriating Herbs]
by Richard Evans Schultes and Albert Hofmann
Jonathan Ott 228

Urbock—Bier jenseits von Hopfen und Malz: Von den Zaubertränken der Götter zu den psychedelischen Bieren der Zukunft [Urbock—Beer Beyond Hops and Malt: From the Magic Potions of the Gods to the Psychedelic Beers of the Future]
by Christian Rätsch
Jonathan Ott 246

Report on the Staten Island Project: The Ibogaine Story
by Paul De Rienzo, Dana Beal and unnamed "members of the project"
Jonathan Ott 270

Los Nombres de los Hongos y lo Relacionado con ellos en América Latina. Introducción a la Etnomicobiota y Micología Aplicada de la Región: Sinonimia Vulgar y Científica
by Gastón Guzmán
Jonathan Ott 317

Gli Allucinogeni nel Mito: Racconti sull'Origine delle Piante Psicoattive [Hallucinogens in Myth: Origin Stories of Psychoactive Plants]
by Giorgio Samorini
Jonathan Ott 318

ETHNOBIOTICA

We approach the arbitrary millennial transition with fear of apocalyptic terrorism and global computer collapse. For the *Journal of Ethnobiology* the approaching transition is less dramatic but significant nonetheless. First of all, it is my great pleasure to introduce my successor as editor, Dr. William Balée of Tulane University, who likely is already well-known to many of you for his fascinating studies of the ethnobotanical knowledge and practice among Amazonian Native communities near the mouth of the Amazon River. I believe Dr. Balée understands and values the full range of ethnobiological pursuits represented within our membership and that he will strive to maintain high quality, broad range, and balance in the *Journal*'s contents during his tenure. Dr. Balée has committed to an initial three-year term, leaving open the possibility of extension. The job is taxing but critical to the continued success of the Society and of our discipline, which is more than ever needed and center stage in today's world.

I will visit Bill at Tulane in May (attending my younger daughter's graduation from Law School in the bargain) and will pass on whatever advice and counsel I can offer. I hope he will be able to convince his university administration of the value of supporting his efforts with generous secretarial support. The editorship is too much for one person on top of his or her regular academic duties without a supporting staff. We will discuss strategies for speeding up every aspect of the editorial process while at the same time holding costs in line. I will urge the Board of Directors to redouble their efforts to recruit new subscribers. We are on the verge of passing the 500-subscriber mark, but given the wide academic, policy, and public interest in ethnobiology today we should be reaching a substantially larger audience. More subscribers means more resources to enhance and expand the *Journal*.

We will co-edit Volume 19, No. 1, for which material is already in hand. Then he'll be on his own. After May 1, 1999 you should send manuscripts for review to Dr. William Balée, Department of Anthropology, Tulane University, New Orleans, LA 70118 (wbalee@mailhost.tcs.tulane.edu).

I want to thank three individuals who over the past several years have given generously of their time in support of the *Journal of Ethnobiology* who are stepping down to focus their energies in new directions: News and Comments Editor Gary Martin, Book Reviews Editor Sandra Peacock, and French language consultant Daniel Clément (see his historical analysis in this issue). Sandra's replacement is already on board. Welcome Michael K. Steinberg, Department of Geography and Anthropology, Louisiana State University, Baton Rouge, LA 70803 (msteinb@tiger.lsu.edu) as our new Book Reviews editor. Volunteers for the other two open slots are welcome.

I would also like to thank students and former students at the University of Washington who have helped get the *Journal* out in good order: Jennifer Sepez Arandanas, Brian Van Hoy, and Jill Grady. Not least we owe a big hand to the Editorial Board members who coordinate our review process. I hope that many will continue in that capacity under Bill Balée's editorship.

In conclusion, I offer this summary of the range of contributions published during my editorial tenure. Thirty-six articles were published in the seven issues from volume 15, number 2 through volume 18, number 2. Of these, 27 (75%) treated ethnobotanical subjects, six (17%) were ethnozoological, and three (8%) were general in scope. Seven (19%) were archaeological in focus, another seven treated medicinal applications, while nine (25%) had some other utilitarian focus. Seven dealt with what we might best characterize as "intellectual" aspects, five (14%) were ecological, and one was an historical overview. Geographic foci remain strongly American, with 10 articles treating cases from North America, six from Central America, and seven from South America (64% New World). Five articles treated cases from Asia, two from New Guinea, two from Africa, and one from Europe. Two had no clear regional focus. Though rather weighted towards the New World, I believe the *Journal* reflects the diversity and balance of interests of our members.

Eugene Hunn

AUTHOR PROFILES

Daniel Clément (not pictured) is Adjunct Professor at Laval University in Quebec, Canada, and is a private consultant in anthropology. He was Curator of Ethnology, Eastern Subarctic at the Canadian Ethnology Service 1991-1998. His research focuses on the relation between people and their environment. He has worked mainly with Native people in Canada and Creoles in La Réunion and Guadeloupe.

Gregory Forth (D. Phil., Oxford) is a social and cultural anthropologist specializing in eastern Indonesia, where he has conducted several years of field research. At present he holds the rank of Professor in the Department of Anthropology, University of Alberta. In addition to numerous articles, his publications include *Rindi: An Ethnographic Study of a Traditional Domain in Eastern Sumba* (1981) and *Beneath the Volcano: Religion, Cosmology and Spirit Classification among the Nage of Eastern Indonesia* (1998).

Christine A. Hastorf is Associate Professor of Anthropology at the University of California, Berkeley where she oversees the McCown Archaeobotanical Laboratory. She has conducted archaeological and archaeobotanical research in the Andes for over 20 years, primarily in the highlands of Peru and Bolivia. She currently directs a project on the Taraco Peninsula of Lake Titicaca. Her plant studies focus on the political, economic, and cultural aspects of wild and domestic plant use in later prehistory. She was a faculty member at the University of Minnesota when the present fieldwork and analysis was conducted. **Melanie F. Wright** (not pictured) is Director of User Services at the U.K. Data Archive at the University of Essex, Colchester, England, and an occasional lecturer in the Latin American Studies program there. She has worked as paleoethnobotanical specialist on archaeological sites in North and South America, with a concentration at Tiwanaku in Bolivia. Her research interests include theories of social difference, particularly with reference to gender and ethnicity; the relationship of natural science data and method with cultural/sociological interpretation; the political and social role that interpretations of the past play in the present; and quantitative methods and practice in social research.

Kelly Kindscher is Assistant Scientist at the Kansas Biological Survey and Courtesy Assistant Professor in the Environmental Studies Program at the University of Kansas. He teaches ethnobotany and environmental impact assessment and has an active research program in plant community biodiversity, prairie and wetland plant ecology, ecological

restoration, and edible and medicinal plants. **Kirk P. Manfredi** is Associate Professor of Chemistry at the University of North Iowa. His interests include environmental chemistry, polymer chemistry, chemical education, and natural product chemistry. He has published on novel alkaloids from the Cameroon plant *Ancistrocladus korupensis* and pursues research on isolating medicinally active compounds from prairie plants. **Melissa Britton** (not pictured) has an undergraduate degree in chemistry from the University of Northern Iowa and currently teaches chemistry at Postville High School, Postville, Iowa. **Maria Demidova** graduated from Herzen State University in Saint Petersburg, Russia with a major in chemistry and English. As an international exchange student she worked in Dr. Manfredi's lab. She is currently teaching English in St. Petersburg, Russia. **Dana Price Hurlburt** is a doctoral student in Systematics and Ecology at the University of Kansas supported by the University's Self Graduate Fellowship Program. She studies the sustainability of wild harvests of *Echinacea angustifolia*.

Justin M. Nolan is a Ph.D. candidate in Anthropology at the University of Missouri, Columbia. His master's thesis examined factors influencing medicinal plant knowledge and classification in the Ozark and Ouachita Mountains of Missouri and Arkansas. His research interests include medical ethnobotany, cognition and emotion, and studies of vernacular cultures and folkways in the rural US. At present, he is conducting dissertation fieldwork on ethnobotanical knowledge variation in a folk cultural region of the American Midwest.

Donn L. Todt is horticulturist for the City of Ashland, Oregon. Since 1992 he has served as ethnobotanist for the Upper Klamath River Archaeology Project. His research interests include landscape ecology and plant biogeography and their ethnobotanical applications. **Nan Hannon** has conducted archaeological research in Oregon and ethnographic research in Africa for the U.S. National Institutes of Health. During her ten-year tenure as curator of the cultural resource center in Ashland, Oregon she organized the first symposium on the Indians of southwest Oregon. Todt and Hannon coordinate the Acorn Project, a long-term study of the periodicity and productivity of the acorn resource in southern Oregon and northern California.

Journal of Ethnobiology 18(2):161-187 Winter 1998

Editor's note: This article is an edited translation of "Les fondements historiques de l'ethnobiologie (1860-1899),", which appeared in *Anthropologica* 40: 109-128 (1998). It is not our policy to publish translations, but the editorial board judged this historical analysis of particular interest and that it should therefore be made more readily accessible to an English-speaking audience.

THE HISTORICAL FOUNDATIONS OF ETHNOBIOLOGY (1860-1899)[1]

DANIEL CLÉMENT
Canadian Ethnology Service
Canadian Museum of Civilization
Hull, Quebec
Canada J8X 4H2

ABSTRACT.—The origin of ethnobiology, defined here as the study of the biological sciences as practiced by the various peoples studied by ethnology, can be traced to the end of the 19th century when different names were given to its subdisciplines. Those names — applied botany, Aboriginal botany, botanical ethnography, ethnographic conchology, botany, ethno-conchology, plant-lore and, finally, ethno-botany and ethnozoology — appear in a context where Westerners were mostly interested in the economic utility of aboriginal products made of plant or animal material. The researchers — botanists and zoologists, as well as ethnologists, missionaries, and adventurers — often worked for museums. They denied any form of scientific knowledge to indigenous people. They were more interested in the products which could be used by Western civilization than in the knowledge of the people they assigned to a savage state.

RESUMEN.—El origen de la etnobiología, definida aquí como el estudio de las ciencias biológicas tal como son practicadas por los diversos grupos humanos estudiados por la etnología, puede ser rastreado a finales del siglo XIX, cuando se le dieron diferentes nombres a sus subdisciplinas. Estos nombres — botánica aplicada, botánica aborigen, etnografía botánica, conquiliología etnográfica, botánica a secas, etno-conquiliología, folklore de plantas y, finalmente, etnobotánica y etnozoología — aparecen en un contexto en el cual los occidentales estaban interesados principalmente en la utilidad económica de los productos aborígenes hechos de materiales vegetales o animales. Los investigadores — botánicos y zoólogos, así como etnólogos, misioneros y aventureros — frecuenemente trabajaban para museos. Ellos les negaban cualquier forma de conocimiento científico a los pueblos indígenas. Estaban más interesados en los productos que pudieran ser usados por la civilización occidental que en el conocimiento de las gentes a quienes asignaban a un estado salvaje.

RÉSUMÉ.—L'origine de l'ethnobiologie, en tant qu'étude des sciences biologiques telles qu'elles se pratiquent dans les diverses ethnies étudiées par l'ethnologie, peut être retracée à la fin du XIXe siècle alors que diverses appellations pour ses

> sous-disciplines sont proposées. Ces diverses appellations — botanique appliquée, botanique aborigène, ethnographie botanique, conchyliologie ethnographique, botanique tout court, ethno-conchyliologie, folklore végétal et finalement ethno-botanique et ethnozoologie — voient le jour dans un contexte où priment des intérêts manifestes de la part des Occidentaux pour les usages économiques des produits autochtones à base végétale ou animale. Les chercheurs, botanistes, zoologistes mais aussi ethnologues, missionnaires, aventuriers, travaillent souvent pour des musées, nient toute connaissance scientifique aux autochtones et, par conséquent, s'intéressent davantage aux produits susceptibles d'être utilisés par la civilisation qu'aux savoirs des peuples, qui, dit-on, vivent encore à l'état sauvage.

Ethnobiology is the study of the biological sciences as they are practiced by the various peoples studied by ethnology[2]. Hence it is as concerned with the botanical and zoological knowledge, present and past, of the various peoples of Africa, the Americas, Asia, or Australia as with biology as manifested in our Western societies. The term "ethnobiology" first appeared in the United States in 1935 (Castetter). The term is a compound of two elements, "ethnos" and "biology," after the fashion of many similar terms formed since the words "ethnography" and "ethnology" were coined in the late 18th century. Parallel terms include ethnobotany (Harshberger *in* Anonymous 1895b), ethnozoology (Mason 1899), ethnoscience (Murdock *et al.* 1950), ethnolinguistics (mid-20th century), ethnohistory (mid-20th century), and so on. The above definition of the term ethnobiology follows the same principle as that which gave rise to these other fields of ethnology. For example, if ethnolinguistics and ethnohistory can be defined as the study of the various languages of peoples in their cultural context and the study of the history of various peoples as they recount it, ethnobiology cannot be conceived otherwise, i.e. other than from the point of view of the people primarily concerned. This is less than the comprehensive study of <u>all</u> the relations that humans have with plants and animals, as that would include ethnobiology in the strict sense just noted, as well as paleoethnobotany, plant and animal pharmacognosy, zooarchaeology, the study of crop plants and domestication, etc. We shall have to wait some time yet for the homogenous methodological and theoretical foundations of such a discipline to be laid.

There are operative and theoretical advantages of employing a strict definition of ethnobiology that is more limited in scope than that which now prevails in certain specialist circles. First of all, such a definition allows one to definitively attach the discipline to the social sciences by distinguishing it from the practical applications of botany and zoology, which some have christened economic or applied botany and zootechny. It is a logical extension from most of the other "ethno-" disciplines, and it promotes a better understanding of ethnobiology's historical development by emphasizing the scientific knowledge that various peoples have regarding the biological elements they find around them, a key aspect of the general relations between human beings and their environment, one which had already been sensed in the last century.

Historically, science is presumed to be a product of Western societies. Recognition that other peoples could engage in scientific work is very recent, if expressed at all. It is a question of power, which can be measured by the number and pejorative quality of the terms used by Western scientific authorities to distinguish

"scientific" knowledge from that which is not. For example, the sciences of non-Western peoples have been labeled "folklore," "natural knowledge," "pre-science" or "para-science," if not as "natural history," "knowledge" pure and simple, "traditional ecological knowledge," or simply as a world view. A similar situation prevails in many circles as to the actual possibility that societies other than the major civilizations may have highly developed language systems. Languages of tribal or indigenous peasant communities are often called "dialects." This also calls to mind our religious past, when Christianity held a central position of authority and all the other religions were relegated to the status of paganism, idolatry, or superstition. Now that power has shifted from religion to science, the dominant societies claim the prerogative of science.

The history of ethnobiology, which spans a little more than a century (1860 to the present), testifies to some changes of attitude regarding the status of non-Western peoples' knowledge. This is apparent in the writings of many authors from North America, Europe, and elsewhere, who have shared an interest in the study of the knowledge that various peoples have of their plants and animals. These authors — physicians, archaeologists and botanists as well as ethnologists — were initially attentive only to the economic uses that these peoples made of the biotic elements in their surroundings. They next turned in succession to vernacular nomenclature, systematic classifications, and finally, knowledge of resources and how to manage them. These major divisions fall into three periods. The first period, which we might call the "preclassical," began in the last century when the foundations of the discipline were laid and its various branches, e.g., ethnobotany and ethnozoology, first designated and defined. This period ended in the 1950s when the attention of ethnobiologists turned from an etic representation and evaluation of Aboriginal sciences (economic uses, general knowledge, first syntheses) to an attempt at emic study of the same phenomena, this time based on the perceptions peculiar to those primarily concerned (local knowledge from an Aboriginal perspective and major classification studies). This second period, which one of its critics (Murray 1982) has termed the "classical" age of the discipline, extended until the 1980s, when major shifts in interest again occurred. The third or "postclassical" period has seen the emergence of marked co-operation between Western scientific researchers and Native peoples. These advances have raised new questions that flow from Western societies' control of knowledge of the resources of the ethnic groups studied. In the 1990s, issues of cooperative resource management, indigenous intellectual property rights, the control of world databases, etc. are in the foreground.

This study is particularly concerned with the preclassic period of ethnobiology, and focuses on the period which produced the initial designations, ethnobotany and ethnozoology. This stage, which extends from 1860 to 1899, is mainly the province of American and European authors. Of course, the origin of ethnobiology *lato sensu* lies deep in the mists of time, when the first hominids took an interest in plants and animals; it can rightly be argued that the foundations of ethnobiology were laid long before the 19th century, and are to be sought in the sacred texts, oral or written, that form the substructure of many civilizations.

However, this is not our subject here. The limits we have set ourselves are

defined by the appearance of the first formal academic designations. All of the researchers and the few rare historians of ethnobiology (Chandra 1991; Ford 1994 [1978]; Ford 1994; Davis 1994 [1991]) concur in acknowledging a common origin, attributing for example to Harshberger (1896c) the initial formulation of the aims of ethnobotany. The ideological context of the proliferation of terms for ethnobiology in fact makes up the content of the historical analysis that follows.

SCIENCE DENIED

At the end of the last century, the distinction between civilized and uncivilized was pervasive, not excepting many works devoted to the study of peoples' knowledge of plants and animals. This distinction was no doubt related to one of the concerns of the age when ethnography as a discipline was born, namely the study and classification of races. This concern was central to the anthropological evolutionism of the time, which held Western civilization to be the culmination of all human development. However, it took on a particular tone when naturalists, physicians, and even ethnologists were describing and analyzing the plant and animal data brought back from their sojourns among men reported to be still living as savages.

It seems in fact that one of the prerequisites for presenting any knowledge foreign to "civilized" society was first of all to rank it as inferior to that of "civilization." This made the knowledge inoffensive, though it might well be very complex. How it might be used was one of the main areas in which this knowledge provoked interest. For if the knowledge of strange new peoples was in no way equivalent to the civilized sciences, that knowledge might nonetheless call attention to potentially useful materials and products.

Savage and civilized stomachs. — This judgment is a recurring feature of late 19th-century ethnographic works on plants and animals, although a grudging appreciation may slip through. For example, Ross (1861, 1862), an agent of the Hudson's Bay Company, in writing about plants and animals of economic value to the Chipewyan Indians of Canada, reports that the products of the Chipewyans, although primitive, "to the philosophic mind [...] would speak volumes, as showing the human intellect, though in its lowest stages, attempting, not unsuccessfully, to break through the surrounding crust of animalism, and struggling to emerge into a sphere of higher intelligence" (1861:433). Moreover, the Chipewyan are without manners and their arts are crude, although they are kind-hearted, "and would doubtless, if dwelling in a more genial climate, prove the most amenable, of any of the red nations, to the humanizing influence of civilization" (1861:441).

Ross was not alone in this view. Robert Brown writes in the *Journal of the Botanical Society of Edinburgh* in a similar vein. He claims to be contributing to "the economic history of plants, and the ethnology of a little known people" (1868:378). Brown, introducing the plant products of the American Indians of the Northwest Coast, writes that these products will be of very little use to "civilised art or medicine" (1868:378). He stresses that the Indians of Vancouver Island — he does not specify which group — naturally do not know the reason why starch is transformed into sugar by cooking, even though they use this conversion process in

roasting the bulbs of camas (*Camassia esculenta*). He dismisses the whole of Indian medicine as nothing but superstition and asserts that Indians detest work; that their innate laziness prevents them from attending properly to their potato crops; and finally, that they are a race on the road to extinction.

One group in particular seemed to represent the lowest level of humanity to these 19th century observers. These are the Digger[3] Indians, who according to Brown are "little elevated in [their] dietary above the lower animals" (1868:385), accompanying their grasshopper dish with a very agreeable salad of white clover (*Trifolium repens*). Palmer (1871:427), a doctor with the United States army refers to the Diggers as "of a low grade of mental organization" (1871:427), embellishing his point by confirming the reports that this people resorts to desperate expedients for sustaining life, feeding on enormous quantities of reptiles, insects, roots, grasses, and lichens. Professional concern leads him to provide a detailed description of the physiological effects of such consumption: "The stomach becomes distended and the visceral function overworked; the organs are enlarged to protuberant dimensions, producing a distortion which would be ludicrous were it not pitiable" (1871:428). The author says that it is also well-known among military men that Indians who eat the white man's food waste away and lead a wretched life; in fact, so incredible is their craving for their wild life that they "hail, therefore, with a yell of pleasure, the opportunity to leap over the bounds of civilization into the wild scenes familiar to their childhood" (1871:428).

Palmer published many works on the useful plants of the Amerindians of North America, chiefly those of the Southwest (1871, 1874, 1878). Yet despite his meticulous inventories of roots, tubers, fruits, nuts, berries, and seeds consumed by Natives, many of which might possibly be adapted for consumption in our societies, he regarded the men whose knowledge he reports as scarcely human. He focuses his disparaging gaze on their repulsive appearance and dietary habits: "in his mode of foraging ... [the Indian] ... resembles in his nature the more savage animals which share the forest with him" (1871:405). They sully their naked bodies from head to toe and show no great concern for the cleanliness of their hair when they consume in group their mush of mesquite seedpods (*Prosopis* sp.), using only their hands as spoons (1871:410); they are fat (1878:594, 596, 648); the men are lazy, leaving the work of gathering and cooking to the oldest women (1878:605); they are obviously not civilized (1871:425); and the "review of the articles of food consumed by the Indians will show that many of the substances are not only distasteful but disgusting to civilized persons, and many, also, are not of a nutritious character" (1871:427).

Palmer goes so far as to identify a type of stomach peculiar to civilization[4], noting that the quantities of nuts ingested by the Indians would unquestionably be dangerous for "more civilized stomachs" (1871:411). Powers (1875), one of the first authors to define the field of ethnobotany, proves no exception in this regard when he acknowledges that many sorts of bulbs (*Brodiaea* sp., *Sanicula* sp., etc.) consumed by the Nisenan[5] are "by no means disagreeable to the *civilized taste*" (1875:377; our emphasis).

Havard, another army doctor, refers to this again in the introduction to his article on the food plants of the North American Indians, where he states that "it may be truly said of some tribes that they reject nothing which their teeth can

chew or their stomachs digest, however tasteless, unclean and repulsive" (1895:98). Even Cushing, considered a genius in his time, who was one of the ethnologists most thoroughly integrated within an ethnic group, cannot refrain from mentioning this. In his famous *Zuñi Breadstuff* he refers to the "Zuñi palate" (1920 [1884-1885]:558), noting the months of training he had to undergo before he could appreciate Indian cooking after his initial reaction of disgust; in this regard, he tells of a prepared dish which reminded him of the taste of a cigarette lit at the wrong end, until at last he became accustomed to it (1920 [1884-1885]:560-561).

Indian medicine is nothing but superstition and fetishism. — Apart from diet, there is another domain that was similarly denigrated in the ethnographic writing of this period. This is medicine, and its attendant objective knowledge of the virtues of plants. It seems to have required but a single step to move from disparagement of Native medicine to a negative assessment of the botanical and zoological knowledge of the peoples encountered, given the close relations that existed in practice between all of these types of knowledge.

In view of the many negative references to him, the medicine man might be supposed to pose a major threat to the civilized world. Some healers may have exploited their patients' naïvete, promising fantastic results through Indian medications, and some remedies may have since proved false. But, systematic denigration of Indian healers certainly served to reinforce the superiority of the dominant society, and may have delayed a higher standard of study, analysis, and understanding of the Amerindian pharmacopoeia.

For example, Brown (1868:390-391) considers medicine men mere sorcerers and Indian medicine nothing but superstition, though he acknowledges that Indian knowledge of the medicinal properties of plants is empirical: "pagan empiricism," as he puts it. This apparent contradiction between superstition and empiricism in the evaluation of Native medical knowledge can also be found in Powers, who warns his readers that there are "many substances popularly called 'Indian medicines' which are humbugs, and which have been fathered upon the aborigines by patent-medicine men" (1875:373). However, Powers refrains from discussing these; his examination is confined to plants about which he has obtained first-hand information. At the same time, he states that the botanical knowledge of Natives is mainly based on bitter experience.

Native medical knowledge itself may be the subject of comment, most often negative. Though Holmes (1884-1885b:304) sees the selection of natural medicines by the Hudson Bay Cree as remarkable, Powers (1875:379) is somewhat less laudatory in comparing the knowledge of the Nisenan to that of the Chinese. Mooney has no praise at all for Cherokee medicine, when he describes their theory and diagnosis as "entirely wrong," and the scientific value of their remedies as "next to nothing" (1891:322). According to Mooney (1891:323), the average wife of an American farmer would know more about the treatment of internal ailments than all of the tribe's doctors put together.

Also judged wanting is the aboriginal knowledge of plants, or rather, the mode of discovery of the powers of plants. It is not the ingenuity of the Natives that is challenged, since this is in part justification for the researchers' interest, nor the Natives' great capacity for observation, for this is often highlighted. Rather the aboriginal mental process is targeted. The researchers — naturalists, physicians,

even ethnologists — strive to differentiate themselves by denying Native thought any, or next to no, scientific character. Aboriginal thought is "strange": according to Brown, "Some of them have strange notions of the best method of cultivation" [1868:380], pondering the behavior of an old Indian chief who regularly stalked through the village in the morning advising his people in a stentorian voice to eat only the small potatoes and keep the big ones as seed for the next crops. This case might be explained on an empirical basis: the selection of stronger specimens to enhance production[6].

Several observers attributed aboriginal medicinal plant use to the Doctrine of Signatures. Palmer cites the homeopathic nature of Indian remedies in the case of the California laurel (*Oreodaphne californica* [= *Umbellularia californica* (Hook. & Arn.) Nutt.]). The leaves of this plant give off a strong spicy odor. According to Palmer, their use was guided by the same principles as those of the German physician Hahnemann, founder of Western homeopathy: "Hahnemann is not the only discoverer of the fact that like cures like; for long before he was born, the Indians of California were aware of the power which this plant had to produce a headache in those that are well and to cure those who are afflicted with it" (1878:652). Mooney explicitly refers to the Doctrine of Signatures to explain Cherokee practices, but more critically:

> It seems probable that in the beginning the various herbs and other plants were regarded as so many fetiches and were selected from some fancied connection with the disease animal, according to the idea known to modern folklorists as the doctrine of signatures. Thus at the present day the doctor puts into the decoction intended as a vermifuge some of the red fleshy stalks of the common purslane or chickweed (*Portulaca oleracea*), because these stalks somewhat resemble worms and consequently must have some occult influence over worms. (1891:322-323)

Hough designated this same mental process "inferential medicine," which he noticed among the Hopi: "Tea made from the thistle is a remedy for prickling pains in the larynx, milkweed will induce a flow of milk, and there are other examples of inferential medicine. Perhaps another class is shown by the employment of the plant named for the bat, in order to induce sleep in the daytime" (1898:139). Some Amerindians interviewed were quite conscious of this reasoning process. Hough's informants explained to him that they ate the leaves and flowers of the *pala katchi* 'red male flower' (*Gilia aggregata*) to hunt antelope, since these were among the antelope's preferred foods. Moreover, a solanum with the evocative name of *cavayo ngahu* 'watermelon medicine (*Solanum triflorum*) was planted with watermelon seeds to influence the harvest, "that is, the watermelon would be influenced to become as prolific as the small plant" (1898:139-140).

Is indigenous knowledge science? — These 19th century observers were at pains to note that while Amerindians may have been excellent, highly experienced observers, they were certainly not scientists: "Among savages, of course, there is no systematic classification of botanical knowledge" (Powers 1875:373). "It is absurd to suppose that the savage, a child in intellect, has reached a higher development in any branch of science than has been attained by the civilized man, the product

of long ages of intellectual growth" (Mooney 1891:329). Every Moki Indian "is a botanist; not a botanist, of course, in the scientific way; one for practical purposes, rather [...]" (Hough 1898:137). The same Moki Indians studied by another author were judged better observers than most white men, but they "are not ornithologists, and cannot be expected to name even all birds that have fallen under their observation [...] or to discriminate between closely related species or those which resemble one another in color or form" (Mearns 1896:393). A "naturalist, on this count, would enumerate, for each area, a long list of invertebrate creatures, of fishes, reptiles, birds, and mammals; but the Indian would not go above a hundred species" (Mason 1899:50).

There are rare exceptions to this rule, but they are not significant, in that they are isolated instances that would not leave their mark on this era as Conklin (1954), Berlin, Breedlove, and Raven (1974), or Hunn (1977) did more than a half-century later. Matthews (1886) is among these exceptional observers. He, with Paso y Troncoso (1883-1884) in Mexico (to whom we shall return), praised aboriginal knowledge with almost no reservation, and for good reason: he studied the vernacular names of plants among an Indian group. It is noteworthy that studies of ethnobiological nomenclature laid the foundation for some of the greatest researches in the history of ethnobiology. Matthews reported that Navajo knowledge is remarkably precise and extensive compared with that of certain white men not versed in botany. Furthermore, their vocabulary is stable, they make distinctions between major species, and they create generalizations for similar species, generalizations which in some cases correspond to ours. For example, they have a generic term for the juniper, *koth*, and recognize the three species present in the region, each of which has its own name. The same applies for the sunflower.

> The most common kind of sunflower bears the name of *indigili;* as with ourselves, this is taken as a type or foundation species of plants in the subtribe Heliantheæ, and we have *indigili nilchini*, strong-scented sunflower (*Verbesina enceloides*), and *indigili nilchinitso*, great strong-scented sunflower (*Helianthus nuttallii*). (Matthews 1886:767)

The goodwill of the odd researcher such as Matthews notwithstanding, egalitarian humanism was less the fashion in the late 19th century than evolutionism. Consequently, the scientific knowledge of the non-Western peoples were denied the status accorded the sciences of civilized man. The situation was much the same on other continents. In France, for instance, botanists, doctors, and army officers who had spent time in the colonies expressed a certain European disdain for indigenous food. For example, Heckel wrote of the shea butter made by the Bambara and Malinke of Niger from seeds of the tree of the same name (*Butyrospermum parkii*):

> The butter thus obtained is of a grainy consistency like tallow and a dirty white colour, sometimes reddish. It has a special odour, one not very pronounced at ordinary temperature but which increases particularly with cooking, sometimes causing a certain repugnance in Europeans called upon to partake of it. (1897:230)

Indigenous therapies were scrutinized; their foundation usually situated at the opposite pole from civilized science. Such was the verdict of the same doctor, a "soldier of science" whose mission was to illuminate the true and the false, to distinguish science from superstition in medicinal plant usage among the aboriginals of the Ivory Coast: "A great many of their curative practices are sullied with superstition, but do we not have our own in this Age of Enlightenment? Our scientific research methods shall refute them, allowing us to separate the gangue from the precious crystal" (Heckel 1900:552).

As in the Americas, the knowledge of indigenous peoples is also called into question. It is seen as partly superstition, a mixture of imagination and empiricism (Lasnet 1900:171), or as fetishistic. Sébire, a missionary and botanist, referring to the aboriginal peoples of Senegal, states that "All of these tribes are fetishistic." He goes on to evoke one of the greatest concerns of civilized man at that time, namely the development of agriculture, and to denounce local farming practice: "The more a country is infected by Islamism, the more agriculture is scorned" (Sébire 1899:xii).

Necessity knows no law. —Native peoples of the internal American colonies and the external European colonies nonetheless demonstrated empirical knowledge. How else justify the effort of studying indigenous knowledge in order to discover useful applications of that knowledge? The most common explanation of this seeming paradox is that, "Necessity knows no law," or, as we might say today, "Necessity is the mother of invention." So Havard introduces his article on Indian food plants: "The maxim that 'Necessity knows no law' is well exemplified in the diet of the North American Indians who, when driven by stress of hunger, eat whatever the animal and vegetable kingdoms bring within reach [...]" (1895:98). Starvation explains their discoveries. Havard cites several cases, such as that of arum roots (Araceae), which could be consumed only after being dried and cooked to remove their characteristic acridity: "The pangs of hunger must indeed have been keen which drove the natives to experiment with them, but the happy discovery was made that drying and cooking dissipated this noxious acridity and that the roots contained a large proportion of nutritious starchy food" (1895:106). Similar reasons are advanced for medicinal plants. Heckel states that the indigenous peoples of the Ivory Coast, "[...] by way of therapeutic resource, they have nothing at their disposal but the plant kingdom where they must find their means of cure" (1900:552). Such discoveries were also the product of luck or chance. So Mooney imagines the emergence of the Cherokee Indian therapeutic system :

> There can be no doubt that in course of time a haphazard use of plants would naturally lead to the discovery that certain herbs are efficacious in certain combinations of symptoms. These plants would thus come into more frequent use and finally would obtain general recognition in the Indian materia medica. By such a process of evolution an empiric system of medicine has grown up among the Cherokees, by which they are able to treat some classes of ailments with some degree of success, although without any intelligent idea of the process involved. (1891:323)

THE ECONOMIC USES OF PLANTS AND ANIMALS

The "discovery" of new uses. — Such dismissive explanations notwithstanding, the research undertaken during this period was motivated by the same Native discoveries of foods and therapies, particularly potentially marketable plants. Writers constantly refer in their studies to previously unknown uses which might benefit more civilized nations. Attention was not confined to plants as foods or medicines; their utility as textiles, fuel, rubber, resins, and ornaments were also investigated. The *Revue des cultures coloniales* (1897-1904), the forebear in France of the *JAT* (*Journal d'Agriculture Tropicale*) and the *JATBA* (*Journal d'Agriculture traditionnelle et de Botanique appliquée*[7]), made this a priority. "The editorial staff of this journal," wrote Lecomte, "will strive to facilitate so far as possible the task of colonial farmers by providing them with the most complete information on the various crops which can be launched in our colonies and on all related questions; fertilizers, crop diseases etc. The natural products of today may be cultivated as crops tomorrow; hence we shall reserve a large place for the study of all usable natural products, such as rubbers, gutta-percha, gums, resins and so on" (1897:4).

The publications of this period also sometimes mention plants discovered among aboriginal peoples that had already proven useful, as justification for more intensive future investigation. In the United States, Harshberger, the founding father of ethnobotany, stressed the contributions Indians have made to the white man: "In fact, most of the plants which the new world afforded were made known in this way; tobacco, chocolate, the potato, maize, and tomato were first used by the Indians of North and South America and afterwards *borrowed* by white men" (1896c:153; our emphasis). Heckel likewise lists the therapeutic products that our Western societies owe to indigenous peoples, such as "*cinchona, opium, ipecac, curare, jaborandi,* and even *jequirity,* [which] are obvious evidence of this special genius among the primitive races" (1900:552).

Numerous studies were devoted to specific animal and plant products, not solely for their industrial or commercial potential, but for reasons ranging from a dawning interest in aboriginal sciences in their own right — although that interest was always marked by economic considerations — to an emerging concern about the disappearance of certain biological species. Examples include a series of articles on maple syrup, its importance to the American economy, and above all its origin, which authors attempted to demonstrate as being Indian (Henshaw 1890; Chamberlain 1891a, b). An evolutionist conception of humanity persisted, with the Indian depicted in his struggle "upwards" for survival and in the "gifts" he made to his conqueror, maple syrup being not the least of these: 36 million pounds of maple sugar produced in 1880 in the United States, yielding a million gallons of syrup at a total value of $4 million. This article by Henshaw also highlights the ingenuity of the Amerindians, such as the Iroquois with their knowledge of how to separate the sugar from the water in sap by simple freezing: the ice that forms on the top of the sap is removed, leaving the unfrozen sugar on the bottom (1890:347). This type of detail is scattered throughout the period documents, and it must be acknowledged that the authors who recorded it probably saved many elements of Native knowledge from oblivion.

The monograph by Cushing (1920 [1884-1885]) on the breadgrains and especially the maize (*Zea mays*) of the Zuñi of the Southwest, with its multitude of ethnographic detail on the agricultural myths, beliefs and practices of these Indians, is another example of a major research project conducted on a single subject. Other examples of the same type include the writings on wild rice (*Zizania aquatica*) by Stickney (1896) and Jenks (1898), particularly the latter's monograph on how the plant was harvested near the Great Lakes, which typically combines ethnographic description with economic evaluation. Jenks (1898:1020) thus provides a nutritive assessment of the wild rice and statistics on its production. The work by Hornaday (1889) on the extermination of the American bison (*Bison bison*) is similarly constructed, with its statistics on the animal's economic importance to the Indians and whites of North America, the hunting methods used, the many products that could be derived from the flesh (jerky, pemmican, marrow, tongue), hide (clothing, blankets, rope, sacks), or other parts (hair as ornamentation, dung as fuel, horns as utensils), and a plea for the protection of other endangered species.

Many French works of the same nature concern such colonial crops as coffee, cacao, date and rubber trees, tea and pepper plants, sugar cane, in short all the products that met the growing needs of the colonies. This research emphasizes indigenous experience in growing crops or even domesticating animals which might be of interest to colonists, and always combines ethnography with economic evaluation. For example, there is one description of the methods of planting and harvesting coconut palm used by the Annamites of Binh-Dinh province in Indochina, of their knowledge about the enemies of this tree, about converting its different parts into rope and oil, and about using its wood for construction and its leaves as vegetable fiber. The same article also features a statistical evaluation, based on a sample of 1,000 nuts, of its yield in various products such as oil and copra (Rideau 1901). Stock breeding on the west coast of Madagascar is given similar treatment when Perrier de la Bathie (1902), himself a breeder, reports details about the hunting of wild oxen (*Bos zebus*) by and with the indigenous peoples, as a way of forming a herd, while supplying figures on the guarding, pasturing, and per-head yield in francs of these animals.

The studies from this period are not all monographs, however. Many are general in nature, comprised of long lists of useful food or other plants in a given region or in several regions together. These lists occasionally allude to products which might be of use to civilized societies. For example, in his long index of plant products used by the Amerindians of the Northwest, Brown (1868:388-389) emphasizes the potential interest of growing wild flax (*Linum perenne*) or an allied plant from which the Indians manufactured nets, twine, and rope, as a textile substitute in the cotton and rope industry. Palmer's list of the food plants of North American Indians also begins with the explicit aim of reporting "many plants almost unknown to the people, and very little known to science, which may be utilized in the arts and in food products" (1871:404). Palmer returned to this theme in 1878, notably to vaunt the merits of a species of yucca (*Yucca bacata*), whose fiber the Indians processed into rope, twine, shoes and mattresses, as a species that could be used to manufacture paper (Palmer 1878:646-647). He also recommended a species of agave (*Agave deserti*) for the same purposes because of its abundance in desert areas not conducive to growing other crops (1878:648). Sage-

brush (*Artemisia tridentata*), used by the Paiute Indians as a medicine, contains a pungent oil which he suggested could become "a profitable article of commerce" (1878:652).

Food plants. — Food plants are often mentioned in these ethnobotanical lists. By this time the most important plants of the New World had already been incorporated into the culture of the dominant societies of the Americas and Europe: potatoes, tomatoes, and corn were part of the daily menu of the French-, English-, and Spanish-speaking peoples of the Americas, and had long since crossed the Atlantic to become almost national dishes in certain European countries. However, Havard for example suggested growing a lesser-known tuber, commonly known as *tipsinah* by the Sioux, *tahgu* by the Osage and "Pomme de Prairie" or "Pomme Blanche" by the Canadian voyageurs (*Psoralea esculenta*), on account of its abundance, wide distribution, nutritive content in starch and nitrogen, and ability to adapt to arid conditions (1895:108). He also recommended the roots of an umbel, *Carum gairdneri*, the *yamp* or *yampah* of the Shoshone Indians, which he noted were not astringent but aromatic, with the taste of sweet nuts (1895:108-109). However, he advised absolutely against certain other plants, such as a passion-flower (*Passiflora incarnata*) from the southern states grown by the Indians of Virginia, since there is little nutritional value in the fruit and it would be difficult to improve the plant (1895:104).

Drink plants. — Beverage plants, tea and coffee substitutes, draw the most attention. Havard (1896) devotes several pages to the leaves of the yaupon (*Ilex vomitaria*) which, in infusion, procured a "black drink" much in vogue among the eastern Amerindians before the contact period. He strongly advises that its economic value be assessed as a substitute for coffee or tea. The subject is also treated in the *Revue des cultures coloniales*, notably in an article on tea substitutes published in 1902 (Anonymous 1902).

Medicinal and stimulant plants. — Medicinal plants were also examined and their value assessed, as in Lasnet's review of the pharmacopoeia of the Sakalava of northwestern Madagascar: "Not all of these medicines are pure imagination [...] intensive examination and minute analysis of them would be very interesting, and would surely reveal the alkaloids that can be used in therapeutics" (1900:171). Other authors go further, offering examples of recent finds. Harshberger cites a tonic whose discovery was facilitated by the Indians' use of a certain plant, which was then studied.

> Again, we may learn by this study new uses of plants of which we were in ignorance. A stimulant and nerve tonic new to materia medica has been discovered in this way. Dr. D. Webster Prentiss discovered the action of the drug popularly known as mescal button, which is yielded by *Anhalonium Lewinii* [*Lophophora* sp.]. He obtained the supplies through agent James Mooney of the U.S. Bureau of Ethnology, who resided among the Indians of the southwest, especially the Kioways, for many years. It is to the use of the mescal button by the Kioways in their religious ceremonies that the white man owes his present knowledge of the drug. (1896c:152)

Many American authors were fascinated by stimulant plants and recommend in-depth expert reports on them. Havard (1896:38-40) reports research done on most of these, starting with peyote (*Anhalonium engelmanni* [= *Lophophora williamsii* (Lem.) Coulter]), which seemed to have remarkable properties. He goes on to list datura (*Datura meteloides*), used by the Indians as a stimulant and narcotic, and the seeds of *Sophora secundiflora*, also used as an intoxicant, which contains the alkaloid sophorin, a narcotic poison.

Alcohol plants. — Plants capable of yielding alcoholic liquors are also given pride of place, and there is much speculation as to whether Indians knew of the distillation process. The Indians of Mexico are acknowledged to have known about fermentation prior to the contact period, such as the Aztecs, who made *pulque* by fermenting the cooked hearts of various species of *Agave*, and *chicha*, a beer-like, maize-based drink (Havard 1896:33-38). Other alcoholic drinks reported include one made by the Tarasco of Mexico from mescal leaves (Bourke 1895:49); the Apaches' *tizwin* or *tulpi*, made from fermented maize, a product introduced from Mexico in the early 19th century; a drink of fermented fruit of the giant cactus (*Cereus* spp. [= *Carnegiea gigantea* (Engelm.) Brit. & Rose]), consumed by the Pima, Maricopa, and Yuma Indians, among others; *colonche*, another beverage of the Indians of Mexico, based on fruits of prickly-pear cacti (*Opuntia* spp.); the mesquite beer (*Prosopis juliflora*) of the Indians of the Colorado and Gila Rivers, and so on (Havard 1896:33-38). Since the Amerindians of the American Southwest and Mexico were familiar with fermentation, there is still debate as to why this process was not known in eastern North America, even though grape vines (*Vitis* spp.) were plentiful and wine making could well have developed.

Substance and product analysis. — Chemical analyses of many plants and of the products themselves were performed to evaluate their composition and with the aim of revealing some unknown active ingredient. In North America, Palmer for example gives the constituents of a bread made from fruit of the western juniper (*Juniperus occidentalis*), consumed by the Indians of Arizona and Mexico: "Water, 14.34; proteine compounds, 5.69; starch, 17.87; sugar, 10.66; cellulose, gum, oil, &c., (by difference) 47.58; ash, 3.86 = 100" (1871:411).

Pharmaceutical journals also published analyses of plants used by Natives. In the *American Journal of Pharmacy*, Trimble (1888-91) analyses five plants supplied to him by Havard, four food plants and one detergent plant. In the latter (*Chlorogalum pomeridianum*) he detects 1.87% saponin (6.95% in the dry bulb), which explains its soapy properties. In the British *Pharmaceutical Journal and Transactions*, Holmes (1883-1884a and b; 1884-1885a and b) comments in turn upon a vegetable tallow from Borneo, obtained from the fruit of *Hopea* spp. and used for various purposes (dyeing, candles, and machinery oil); limes from Trinidad whose oil could be profitably marketed; a Chinese plant with medicinal seeds; and various medicinal plants of the Cree Indians of Hudson Bay. In at least two cases the author provides detailed chemical analyses.

The starch, sugar, and carbohydrate content of a number of plants consumed by the Panamint Indians arouses the interest of Coville (1892), a botanist with the U.S. Smithsonian Institution. Heckel in France comments at length on the chemical composition of the seed used to make shea butter ("hygroscopic water, 6.72;

leaching by petroleum ether: fats, 45.36; leaching by alcohol: tanin, sugar, unidentified matter, 12.60; leaching by water: coloured gummy and other matter, 13.58; leaching by water: fixed salts, 1.82; iodized lime treatment: strange album. matter, 10.25; incineration: fixed salts, 0.18; by difference: ligneous and losses, 9.49") (1897:233), closing with a note on its richness in butterfat.

THE FIRST DESIGNATIONS

During this hectic time of discovery and search for new products, authors introduced neologisms to designate the new discipline or disciplines, proposed general investigatory methods, and carried out syntheses.

The historical context. — Many of the first ethnobiologists worked in museums. Ross (1861), an agent of the Hudson's Bay Company, collected Chipewyan artifacts for a museum in Edinburgh; Rochebrune (1879, 1882-1883) was an assistant naturalist at the Paris *Muséum* and worked with the state collections in the Trocadéro; Holmes (1883-1884a, b; 1884-1885a, b) was curator of the Museum of the Pharmaceutical Society in Great Britain; Mason (1889, 1894, 1899) was curator at the ethnology department of the Smithsonian Institution from 1884 to 1908; Hough (1898) and Fewkes (1896) were associates in the same department; Harshberger (1896a, b, c) was a professor of biology at the University of Pennsylvania, where he laid the foundations of ethnobotany based on a collection of artifacts; and Coville (1895) and Stearns (1889) were or would be curator and associate respectively at the Smithsonian Institution's Department of Biology. It was primarily these authors, particularly Stearns, Rochebrune, Harshberger, Mason, and Coville, who would lay the first foundation stones of ethnobotany and ethnozoology. They were primarily interested in the material products of the peoples they studied, whether archaeological or ethnographic, examples of industrial or of medical arts. This focus on products is central for understanding the origins of ethnobotany and ethnozoology. Emphasis was on economic products first of all, then on the species used to make them.

Let us examine the historical context in which the first formulations of these fields of study emerged. Ethnology was still in its infancy, having been an active concern for barely 50 years. Botanists had just come to an agreement at the Paris International Congress of 1867 on rules of nomenclature which would at least give scientists the world over a better forum for reaching an understanding as to what they were talking about (Lawrence 1951:196). At first, these rules were not religiously followed in writing about the economic uses of plants and animals, but as the discipline developed, they would become a *sine qua non* for any presentation of findings. It should also be added that not only are ethnobotany and ethnozoology among the oldest divisions of ethnology (ethnoecology, ethnoscience, ethnohistory, and ethnolinguistics are terms that were not born until the 1950s), they are also among the most stable, for they are frequently used — especially ethnobotany — and their definition and related methods are continuously being developed (see Table 1).

Applied botany. — In the early 19th century, the French botanist de Candolle (1819 [1813]) had proposed that botany be divided into three branches: botany proper,

TABLE 1. — Ethnobiology-related terms in the 19th century

Year	Author	Term	Definition
1813	Candolle	*Applied botany*	"study of the relations that exist between plants and the human species"
1875	Powers	*Aboriginal botany*	"all the forms of the vegetable world which the aborigines use for medicine, food, textile fabrics, ornaments, etc."
1879	Rochebrune	*Botanical ethnography*	study of plant remains which "provides invaluable information about the diet, hygiene and industry of a people who are no more"
1882-1883	Rochebrune	*Ethnographic conchology*	"that which relates to the use of Molluscs, whether as objects of adornment or industry, or as substances used for food, dyeing, textile fabrics, etc. among ancient and modern peoples"
1883-1884	Paso y Troncoso	*Botany*	plant science
1889	Stearns	*Ethno-conchology*	conchology "in its ethnological aspect"
1886	Matthews	*Plant-lore*	knowledge about plants
1895	Harshberger	*Ethno-botany*	ethno-botany helps elucidate the cultural position of tribes who use plants for food, shelter or clothing; provides information on the past distribution of plants; assists in the discovery of ancient trade routes; and serves to suggest new lines of manufacture
1899	Mason	*ethnozoölogy*	"zoölogy of the region as it is recounted by the savage"

organic botany or plant physics, and applied botany. The latter, defined as "the study of the relations that exist between plants and the human species," would include agricultural botany, medical botany, economic and industrial botany, and other subdivisions. This classification was to go unheeded for some time. Candolle was chiefly interested in botany proper. After briefly alluding to the realm of applied botany, he in effect abandoned it as an independent field, though it had been the subject of numerous, varied annotations in most of the works on plants and animals written since antiquity.

Aboriginal botany. — In 1875 in the United States, Powers — who had more of a background as a journalist and adventurer, having crossed America on foot in

1868 (Powers 1975:221) — proposed another term which proved short-lived. He referred to all of his data on the use of plants by the Bear River Nisenan as "aboriginal botany." These data concerned the economic uses of plants: "As employed in this paper the word, 'botany' is somewhat loosely comprehensive, and is used for the lack of a better. Under it are included all the forms of the vegetable world which the aborigines use for medicine, food, textile fabrics, ornaments, etc." (1875:373). This was the framework for Powers' discussion of 73 plants, identified in Latin with the help of a specialist and presented with their uses. He stated that in no way could the Indians have a classification system. Though they were very good observers, their knowledge as revealed by their complete nomenclature of plants could readily be explained by the pangs of hunger. In thus taking up the usual refrain of the period, Powers was thus clearly asserting, despite his use of the term "botany," that Natives could not claim to have knowledge comparable to that of civilized society.

The term "aboriginal botany" was rarely used. It is to be found in Mason in 1889 and in Coville in 1895, just before the coining of the term "ethnobotany," which was to replace it for good. In Mason (1889:235-239), "aboriginal botany" simply repeats the plant uses of the California Indians based on data from Powers and other sources. Coville uses the term in his "Directions for Collecting Specimens and Information Illustrating the Aboriginal Uses of Plants" (1895). These Directions were published by the U.S. National Museum along with other similar ones for collecting birds, fossil plants, small mammals, physical anthropology specimens, and so on. In France, the fifth edition of the *Instructions pour les voyageurs et les employés dans les colonies sur la manière de recueillir, de conserver et d'envoyer les objets d'histoire naturelle* (1860), published by the Muséum impérial d'Histoire naturelle[8], included an anthropology section for the first time, in addition to the established sections on zoology, botany, mineralogy, and geology. This very short section simply stressed the importance of collecting artifacts such as "weapons, instruments, fabrics, and generally all objects of a nature to furnish information about primitive industries" (1860:15). The zoology and botany sections contained strong recommendations to include in the collection notes the vernacular names of species, the uses made of their various parts, and the "folk opinions or superstitions" entertained in their regard.

Coville's Directions of 1895 reflect the same museological concerns, but they are extremely detailed for the period, and stand out as a founding text in terms of data collection methods. The Directions are also exclusively dedicated to the aboriginal uses of plants — a first in the history of ethnobiology. Coville proposes a set of general methods based on observation and inquiry ("conversation") to obtain data on "aboriginal botany" which is defined, as in Powers, as "primitive uses of plants." Three aspects are discussed: selection of informants (chiefs, medicine men, and Indian teachers are to be preferred), the specimens to be collected (plants as well as plant-based products, at all processing stages), and supporting notes.

Coville provides plenty of information about collection, selecting certain parts of plants to bring back, drying, mounting, and transportation, in short, every step required to create a classic herbarium. It should be remembered that he himself was a botanist. He indicates that all of these instructions have but one purpose —

scientific identification of the plant: "Probably the most important fact to be learned about a vegetable product of aboriginal use is the scientific name of the plant from which it was derived" (1895:4). With this directive, Coville definitively establishes the importance of the scientific name of the biological species as a basis for research and interchange among researchers. Coville (1895:6) also indicates the relevant notes which must accompany every specimen: 1. Number; 2. Common name; 3. Aboriginal name of plant; 4. Aboriginal name of derived product; 5. Tribe; 6. Place; 7. Uses; 8. Part used; 9. Date of collecting; 10. Collector; 11. General remarks. In conclusion, Coville presents a list of the main uses of plants by the Natives of North America. We cannot be indifferent to it, since the author had personally compiled a similar inventory for the Panamint of California (1892). The 1895 list, which aptly illustrates the substantial interest at that time in the products of the peoples studied, can be summarized as follows (1895:7-8):

Food:	
Foods proper	farinaceous, saccharine, herbaceous, fleshy fruits, condiments
Drinks	simple aqueous, acid, fermented, distilled, and narcotic drinks
Clothing	for protection and use; for ornament
House and furnishings	house frames and coverings, beds, and utensils
Heating, cooking, and lighting	matches, tinder, fuel, fire receptacles
Manufacture	general and special tools
Industries	hunting, trapping, fishing and harvesting devices
Travel and transportation	boats, land vehicles, packing utensils, snowshoes
Language communication	paper, ink, pens
War	weapons, painting
Amusement	outdoor and indoor games
Ceremonial and religion	musical instruments, dancing ornaments, pipes, tobacco
Medicinal plants	external and internal use

Botanical ethnography and ethnographic conchology. — In addition to Powers' (1875) "aboriginal botany," two new terms were coined in France at this time by Rocheburne: "botanical ethnography" (1879) for the study of plant usage and "ethnographic conchology" (1882-1883) for the study of the use of molluscs. Rochebrune worked at the Paris *Muséum national d'Histoire naturelle* with burial collections, mainly of South American origin. In the first case, the study of plant remains from the site of Ancon (Peru) "provides invaluable information about the diet, hygiene, and industry of a people who are no more" and proves an "indispensable complement to the ethnographic research" already under way (1879:344). The analysis is organized according to plant product, i.e., food and medicinal plants, followed by industrial and dye plants.

In the second case, comment is made on the uses of molluscs, "whether as

objects of adornment or industry, or as substances used for food, dyeing, textile fabrics, etc." The author invites us on a kind of "journey through the State collections" to explore a field where study is just beginning. Rochebrune quotes from a few works by Stearns, the American who in turn would propose the term "ethno-conchology" in 1889.

Ethno-conchology. — Ethno-conchology is a designation often cited by ethnobiologists as the first "ethno-" related to their discipline to appear in print. Stearns, who at that time had already written a great deal on the use of shells by Amerindians for monetary purposes, succinctly defined it as conchology "in its ethnological aspect." Hence this definition puts the emphasis on conchology, and the hyphenated prefix that associates this science with ethnology in the compound "ethno-conchology" is to be interpreted as an attendant circumstance: the two elements remain isolated; the ethnology aspect simply qualifies the malacology aspect. Stearns was in any case affiliated with a biology department, and his primary interest in usages seems to reflect this. The terms devised by Stearns and Rochebrune were soon forgotten, and subsequently rarely used.

Plant lore or genuine botany? — Those with a real interest in aboriginal knowledge were not legion in the late 19th century. There is Matthews (1886), whom we quoted earlier, who describes the botanical knowledge of the Navajo, particularly their nomenclature, as "plant-lore," a term that would be picked up by Mooney (1889) solely to designate the plant mythography of the Cherokee he was studying. Above all, however, a certain Mexican historian, also mentioned above, stands as a precursor from every point of view, by virtue of his assertions and analyses to the effect that the Aztecs of Mexico had a genuine botany comparable to modern science. This of course is Paso y Troncoso (1883-1884), who left a study of Nahuat botany — which he refers to as "botany" pure and simple, with no qualification — written as the first part of a planned trilogy on the history of medicine in Mexico, which was also to include a study of the materia medica of the ancient Mexicans and an epidemiological study. This trilogy was supposed to stand as a thesis in medicine, but was never finished; all we have is the botanical study, which itself is incomplete (Galindo y Villa 1923).

Paso y Troncoso constructs his argument from historical sources, in particular works by Francisco Hernández (16th century) and Bernardino de Sahagún and various codices. In brief, his thesis is that the ancient Indians developed two sciences of observation, namely natural history and astronomy. Their botanical science achieved a very high degree of perfection and was disseminated even to the least educated classes of society.

Paso y Troncoso assigns much importance to the botanical gardens maintained by the monarchs. Among other things, these gardens allowed for the study of new specimens — chiefly ornamental, medicinal, and food plants — brought back from Aztec conquests in distant regions. Experiments were conducted with the medicinal plants. There were even irrigation systems which made it possible to conserve plants from wet areas or, conversely, arid ones. The Nahua may not have been the only people to maintain such gardens. Oral tradition mentions others among the Tarasco at Pátzcuaro. Paso y Troncoso quotes the following comments by the Italian Conde Carli on the arrangement of the gardens:

> "Bernard Diaz who accompanied Cortez, Herréra and Solis report that the Emperor of Mexico and the Nobles had Gardens where they cultivated medicinal plants for public use, and that they were most proud of this prodigious quantity of medicinal herbs which they had divided into Classes and beds, with surprising intelligence." (Carli *in* Paso y Troncoso 1883-1884:163)

According to Paso y Troncoso, medicine was a major reason for the Nahua's interest in the botanical study of plants. The study of properties had to include a comparison phase, followed by a description which, in Nahua society, took the form of an iconography of nomenclature and classification. This iconography served didactic and mnemonic purposes. The author provides numerous examples, including the following which aptly indicates how a single symbol can encompass a bewildering amount of information about a plant. The symbol is taken from the Codex Mendocino, and refers in this case to a pine:

> The conjunction of these signs tells us: that the plant was arborescent; that the bark was deeply fissured, whether naturally or artificially; that these fissures exuded a resinous product; that the frugiferous inflorescence was sessile, conical in shape, with an uneven reticulate surface by reason of the assemblage of bracts or ligneous scales; and lastly, that the leaves of the tree were linear, stiff and erect. (1883-1884:204-205)

The Nahua had also developed a nomenclature for the parts of plants, which Paso y Troncoso presents and analyses as a "glossology." The plant nomenclature itself was "a systematic nomenclature which shows major analogies with that used by modern science since the time of Linnaeus" (1883-1884:213-214). The author examines in detail the system of names which, like that of Linnaeus, is based on the rule that a good nomenclature must give a true idea of the thing described and mention at least one characteristic property. Nahuat nomenclature is generally binomial, featuring a term for the genus followed by a species qualifier. There are names with three components or more which generally correspond to Linnaeus' varieties. The classification groups also contain prototypes, here referred to as type species, which bear the same name as the generic group. While acknowledging that the Linnean system is more highly developed than that of the Nahua on account of its scope and access to means of communication which allow for the accumulation of knowledge, Paso y Troncoso nonetheless states that if the ancient Mexicans had worked together like European botanists, their science "could no doubt have competed with that of modern times" (1883-1884:217).

While it has its imperfections, the Nahuat classification demonstrates some major similarities with modern classification. It is based on dual horizontal and vertical differentiation, since it assumes "ready recognition of each element that is grouped, and distinction of these elements from each other, and from one group to another" (1883-1884:224). According to what Hernández reports, the number of plants classified, synonyms excluded, is 1,000, compared with the 600 plant species which form the basis for the work by Dioscorides, the Greek physician. The Nahuat classification is the product of observation, comparison and experimentation, as in the Old World. Finally, Paso y Troncoso claims that it can be divided

into two very close branches: an artificial (or arbitrary) classification and a natural classification. The author presents a few examples of the first system, giving classification terms and their operative mode for the following groups: 1) *xihuitl* 'grasses', 2) *quahuitl* 'trees', 3) *mecatl* 'cord plants', 4) *patli* 'medicinal plants', 5) *quilitl* 'food plants, cultivated and gathered', 6) *xochitl* 'flowers, ornamental plants'. The second system was never to be presented, for the study by Paso y Troncoso ended just when most awaited.

Paso y Troncoso's work is not well known. It is not quoted by the historians of ethnobotany, and when other authors refer to it they ignore its significance. Paso y Troncoso spoke about Aztec botany, not "Aztec *folk* botany" (Atran 1990:20; our emphasis) or "classical Nahuatl *ethno*botany" (Berlin 1992:110; our emphasis), as it is termed by two modern writers. The difference is subtle but important. At issue is whether or not non-Western societies have knowledge equivalent to science. From this perspective, Paso y Troncoso remains a founding father of ethnobotany and ethnobiology. His analyses of glossology and classification, which clearly stray from a strict concern about products, stand as precursors, long before their time, of the work on nomenclature and classification that will be done, mainly in North America, in the 1950s and afterwards.

Ethno-botany. — The major contribution of this Mexican Americanist notwithstanding, when it comes to associating one name with the foundation of ethnobiology and, in particular, ethnobotany, the unanimous choice is J.W. Harshberger. In Europe, the Americas, Asia, and Africa, all concur in regarding him as the father of the term ethnobotany, which first appeared as the qualifier and compound "ethnobotanic" in a Philadelphia newspaper on October 26, 1895 (Anonymous 1895a). The article in question, by an unknown journalist, summarized certain comments by Harshberger which would be published the following year in a scientific article (Harshberger 1896a), or as part of a scientific article (Harshberger 1896b, 1896c), on the possibility of creating a "Public Ethno-botanic Garden" adjoining the future museum buildings planned by the University of Pennsylvania at Philadelphia. This garden, which apparently was never established, would have had the dual mission of public education and assistance in scientific research. The context of this first mention of ethnobotany is very significant. That context is still museological: hence it is material, in this case the plant collection, which serves as the basis for the discipline. The article states that Harshberger is also a university professor, an instructor in botany, general biology, and zoology: the product of a biologist, "ethno-botany" is thus still conceived with a hyphen, and despite the fact that this is an ethnology and archaeology museum, support for the garden is primarily botanical, since it is plants that will be exhibited (maize, sunflower, tobacco, tomato, potato, oak, etc.) and not ethnographic artifacts.

On December 4, 1895, Professor Harshberger delivered an address to the Archaeological Association of the same university which was reported in the local newspaper (Anonymous 1895b). In early 1896 this speech was simultaneously published in two scientific journals, one botanical, *The Botanical Gazette*, and the other historical, ethnological and archaeological, *The American Antiquarian*. In it Harshberger formulates the four basic objectives of the discipline, illustrated with examples from European archaeology, but chiefly with artifacts of Amerindians

from the Southwest (Anasazi), comprising an archaeological collection presented at an international exhibition. These objects are all plant products — chiefly foods, clothing, and utensils. The four objectives are as follows:

1. "The study of ethno-botany aids in elucidating the cultural position of the tribes who used the plants for food, shelter or clothing."
2. "An ethno-botanical study throws light upon the past distribution of plants."
3. "An ethno-botanical study helps us to decide as to the ancient trade routes."
4. "Ethno-botany is useful as suggesting new lines of manufacture."

The first objective is typical of its period, since it implies an evolutionist breakdown of peoples as "savage, pastoral, agricultural, and civilized" (1896c:146). The second reflects purely botanical concerns, since it involves discovering the migration routes of plants as hidden behind the routes of the humans investigated in the third objective, concerning trade routes. The final objective is also typical of the period, since it refers to the idea of discoveries of new uses or new techniques of manufacture. An example of a "new" drug was given in this regard.

Harshberger also goes into some detail about the methods that can draw the maximum of information from the products or plants studied in "ethno-botany" (microscopic examination, formula for determining the specific gravity of specimens, ash determination, weighing, dendrochronology). He insists on microscopic study as proper to the discipline: "The especial province of ethno-botany is to study microscopically the nature of the fiber employed, as in many cases new methods of obtaining raw materials from hitherto undeveloped sources might be suggested" (1896c:152). The author closes with a plea for appropriate research resources, which should include a collection of seeds from each plant, microscopic slides, and above all, as we have mentioned, a garden, which should allow for the conservation of live specimens which could be used, for example, for comparison purposes to identify the plants used to manufacture the products analysed.

Harshberger's text is the first formulation of theory in the field of ethnobotany. The objectives it targets are still strongly influenced by botany and museological interests, but the process has been set in motion, and it will snowball. To this day, ethnobotany has remained the single most stable and most widespread term in ethnology to designate one of its fields of activity.

The influence of Harshberger was immediately felt in what appears to be the first academic thesis in the field, although its author Jenks (1898 for the published version) speaks of a research project in "primitive economics" rather than in ethnobotany. However, his dissertation, presented in Madison at the University of Wisconsin's School of Economics, Political Science and History, concerns a plant, wild rice; and in his introduction, while not officially quoting from Harshberger, the author unquestionably refers to him when formulating the results he has achieved: "This study has *helped to elucidate the culture position of the tribes* which used wild rice [...]. It has given a detailed picture of aboriginal economic activity [...]. It has thrown light upon the almost constant warfare between the Dakota and Ojibwa Indians [...]. It has *suggested new lines of manufacture*" (Jenks 1898:1019; our

emphasis). Here is a verbatim statement of two of the four objectives set forth by Harshberger in his text of 1896(c).

During the same period, Harshberger also had — or may have had[9] — an influence on a few U.S. ethnologists who referred to ethnobotany to describe or present their work, although they used the term without a hyphen (Fewkes 1896; Hough 1897, 1898). In doing so they perhaps considered ethnobotany as an activity which rightfully falls within the scope of ethnology, something not suggested by Harshberger's compound of ethno-botany, which conveyed more the idea of botany as applied to ethnology. Whatever the case, "ethno-botany" was not to disappear — it would even be used by certain ethnologists — and the constant to-and-fro between the two forms, and indeed the two concepts, was to fuel in part the development of the new field of research.

Ethnozoölogy. —In 1899, Mason, a curator at the Smithsonian's Department of Ethnology, coined the term " ethnozoölogy," using the same model as Harshberger but with more emphasis on the ethnological aspect, Mason defined "ethnozoölogy" as the "zoölogy of the region as it is recounted by the savage" (1899:50), which he conceived as a division of a broader science called "zoötechny", whose task it is to study "all industries associated with the animal kingdom" (1899:45). "Zoötechny" had seven branches: 1) American Indian zoölogy, 2) methods of exploiting animals, 3) the elaboration of products from animals, 4) the products themselves, 5) social organization of the users, 6) knowledge about animals, and 7) religious aspects of man-animal interaction. The fact that Mason excludes " knowledge" about animals from "American Indian zoölogy" ("or ethnozoölogy in America") in itself tells us something about his definition of the latter term. For Mason, " ethnozoölogy" amounts to an Aboriginal list of the animals used particularly the subsistence species — in the region studied by the ethnologist. To illustrate, he cites many supporting examples of lists of animals reported by Americanist ethnologists who had worked with Indians from Alaska to Tierra del Fuego. On the other hand, the whole linguistic aspect of knowledge, whether the Native nomenclature for the "different forms of animal life" or for "different parts of the animal's body," is relegated to the sixth branch of "zoötechny," namely, "knowledge about animals" (1899:79).

CONCLUSION

In the years ahead, ethnozoology would not experience the same good fortune as ethnobotany, whose position would be constantly consolidated. This may have been due to the excessive subdivision proposed by Mason in his initial text, or his treatment of ethnozoology as part of a science and not a science in itself[10]. However, the two pillars of ethnobiology had now been erected. The material and economic base had been identified. Mason, Harshberger, as well as the other theorists and practitioners of the late 19th century, were primarily interested in economic uses of the biological elements in the environment; and it is the study of these products, old or new, archaeological or contemporary, and that of the materials used by Natives to manufacture them, that were at the core of such investigations. The initial threefold origin of ethnobiology — economic, material, and museological — would continue to mark the orientation of this discipline for a long time to come.

NOTES

[1]This text is an abridged version of the first chapter of a work being prepared on the history, theories, and methods of ethnobiology made possible by a research associate contract in 1996 at the Laboratoire de Langues et Civilisations à Tradition Orale (LACITO, UPR 3121), of the Centre national de la recherche scientifique (CNRS) in Paris. The text was first written in French and has appeared as such in *Anthropologica* (40:109-128, 1998) the official publication of the Canadian Anthropology Society. Michael Ustick is responsible for this translation into English.

[2]This definition is discussed further in Clément (1995:5-61; 1998).

[3]In the 1970s, the term «Digger» was still being used pejoratively to designate chiefly the Nisenan, a Maidu people of California. They traditionally fed on various roots, grasshoppers, ants, etc. (Wilson and Towne 1978).

[4]This question of a different stomach must be considered in its context, namely the evaluation of races, a concern already noted in respect to the distinction between civilized and uncivilized that suffuses many studies of that period. It is not specific to ethnobiology. As William Balée told me — for which I am very grateful — the well-known anthropologist W.H.R. Rivers (1901) held the same opinion when he suggested that the paucity of color terms in "primitive" languages could probably be attributed to a physiological difference of the retina of the people under study (Berlin and Kay 1969:148).

[5]Powers probably assessed differently the same Nisenan that Palmer and others disparaged.

[6]I am thankful to Gary J. Martin for having directed my attention to this phenomenon.

[7]This is its most recent name. Since its creation in 1921, the journal has had various titles and subtitles.

[8]By the early 19th century, at least one methodological text specifically devoted to the collection of ethnographic data had been written as part of Baudin's French expedition to Australia (Copans and Jamin 1978). However, this text by J.M. de Gérando, «Considérations sur les diverses méthodes à suivre dans l'observation des peuples sauvages, 1800,» was to have very little influence on the development of French anthropology. So far as our subject is concerned, it contains no particular directive regarding methods of ethnobiological investigation, any more than the text by F. Péron published as part of the same expedition, «Observations sur l'anthropologie, ou l'histoire naturelle de l'homme, 1800,» which at most insists on the need to take an interest in Aboriginal medical knowledge. Fowler (1975), in his inventory of inquiry methods used in anthropology up until the 19th century, reports a few questionnaires which include aspects of ethnomedicine and one questionnaire on animal superstitions (Thomas 1900). Fowler (1975) does not cite Coville's Directions of 1895. Thomas's questionnaire on animals is probably the first published questionnaire of an ethnozoological nature.

[9]Fewkes published his "A Contribution to Ethnobotany" in the January issue of the *American Anthropologist* of 1896. He does not refer to Harshberger and his article must have been submitted in 1895, about the time Harshberger coined the term ethno-botany. It is still unknown if Fewkes was influenced by Harshberger or if he coined the term independently.

[10]Mason's contribution has fallen into oblivion; this article is never cited and ethnobiologists invariably attribute the original coining of the term "ethnozoology" to J. Henderson and J.P. Harringtonin in 1914.

ACKNOWLEDGEMENTS

I wish to thank all the members of the cultural linguistics department of the LACITO (CNRS) in Paris who kindly commented on the first draft of this text, as well as the three anonymous reviewers of the *Journal of Ethnobiology* who provided useful comments. Thanks also to Michael Ustick for translating the article into English.

LITERATURE CITED

ANONYMOUS. 1895a. Museum and garden. Philadelphia Evening Telegraph, 26 Oct., pg. 5.

ANONYMOUS. 1895b. Some new ideas. Philadelphia Evening Telegraph, 5 Dec., pg. 2.

ANONYMOUS. 1902. Les succédanés du thé. Revue des cultures coloniales XI (107):114-117.

ATRAN, SCOTT. 1990. Cognitive Foundations of Natural History. Towards an Anthropology of Science. Cambridge University Press, Cambridge, and Éditions de la Maison des Sciences de l'Homme, Paris.

BERLIN, BRENT. 1992. Ethnobiological Classification. Principles of Categorization of Plants and Animals in Traditional Societies. Princeton University Press, Princeton, New Jersey.

———, DENNIS E. BREEDLOVE, and PETER H. RAVEN. 1974. Principles of Tzeltal Plant Classification. An Introduction to the Botanical Ethnography of a Mayan-Speaking People of Highland Chiapas. Academic Press, New York and London.

——— and PAUL KAY. 1969. Basic Color Terms: Their Universality and Evolution. University of California Press, Berkeley and Los Angeles.

BOURKE, JOHN G. 1895. The Folk-Foods of the Rio Grande Valley and of Northern Mexico. Journal of American Folk-Lore 8 (28):41-71.

BROWN, ROBERT. 1868. On the vegetable products, used by the north-west American Indians as food and medicine, in the arts, and in superstitious rites. Transactions of the Botanical Society of Edinburgh IX:378-396.

CANDOLLE, A.-P. de. 1819 [1813]. Théorie élémentaire de la Botanique ou Exposition des Principes de la Classification naturelle et de l'art de décrire et d'étudier les végétaux. 2nd edition. Deterville, Paris.

CASTETTER, EDWARD F. 1935. Uncultivated Native Plants Used as Sources of Food. Ethnobiological Studies in the American Southwest I, Biological Series 4 (1). University of New Mexico Bulletin 266, Albuquerque.

CHAMBERLAIN, ALEXANDER F. 1891a. The maple amongst the Algonkian tribes. American Anthropologist 4(1):39-43.

———. 1891b. Maple sugar and the Indians. American Anthropologist 4(4):381-383.

CHANDRA, SUDHIR. 1991. Foundations of Ethnobotany (Pre-1900 Ethnobotany). Deep Publications, New Delhi.

CLÉMENT, DANIEL 1995. La zoologie des Montagnais. Ethnosciences 10. Peeters-Selaf, Paris.

———. 1998. L'ethnobiologie / Ethnobiology. Anthropologica 40(1):7-34.

CONKLIN, HAROLD C. 1954. The relation of Hanunóo culture to the plant world. Ph.D. dissertation. Yale University, New Haven, Connecticut.

COPANS, JEAN, and JEAN JAMIN (editors). 1978. Aux origines de l'anthropologie française. Éditions Le Sycomore, Paris.

COVILLE, FREDERICK VERNON. 1892. The Panamint Indians of California. American Anthropologist 5 (4):351-361.

———. 1895. Directions for collecting specimens and information illustrating the aboriginal uses of plants. Bulletin of the United States National Museum 39, Part J:1-8.

CUSHING, FRANK HAMILTON. 1920 [1884-1885]. Zuñi Breadstuff. Indian Notes and Monographs 8:1-673.

DAVIS, WADE. 1994 [1991]. Towards a new synthesis in ethnobotany. Pp. 341-357 *in* Las Plantas y El Hombre. Memorias del Primer Simposio Ecuatoriano de Etnobotánica y Botánica Económica. M. Ríos and H. Borgtoft Pedersen (editors). Ediciones ABYA-YALA, Quito, Ecuador.

FEWKES, J. WALTER. 1896. A contribution to ethnobotany. American Anthropologist 9:14-21.

FORD, RICHARD I. 1994. Preface to second edition. Pp. viii-xxxii *in* The Nature and Status of Ethnobotany. Richard I. Ford (editor). Museum of Anthropology, Anthropological Papers No. 67. University of Michigan, Ann Arbor.

———. 1994 [1978]. Ethnobotany : Historical Diversity and Synthesis. Pp. 33-49 *in* The Nature and Status of Ethnobotany. Richard I. Ford (editor). Museum of Anthropology, Anthropological Papers No. 67. University of Michigan, Ann Arbor.

FOWLER, D. D. 1975. Notes on inquiries in anthropology: A bibliographic essay. Pp. 15-32 *in* Toward a Science of Man. Essays in the History of Anthropology. T.H.H. Thoresen (editor). Mouton Publishers, The Hague.

GALINDO Y VILLA, JESUS. 1923. Don Francisco Del Paso y Troncoso. Memorias y Revista de la Sociedad Científica "Antonia Alzate" 42 (3-6):135-304.

HARSHBERGER, JOHN W. 1896a. Ethnobotanic gardens. Science N.S. 3(58):203-205.

———. 1896b. The purposes of ethnobotany. The American Antiquarian 17(2):73-81.

———. 1896c. The purposes of ethnobotany. The Botanical Gazette 21:146-154.

HAVARD, V. 1895. Food plants of the North American Indians. Bulletin of the Torrey Botanical Club 22 (3):98-123.

———. 1896. Drink plants of the North American Indians. Bulletin of the Torrey Botanical Club 23 (2):33-46.

HECKEL, E. 1897. Sur l'arbre africain qui donne le beurre de Galam ou de Karité, et sur son produit. Revue des cultures coloniales 1(6):193-198; 1(7):229-233.

———. 1900. Contributions à l'étude des plantes médicinales et toxiques employées par les indigènes de la Côte d'Ivoire (Afrique occidentale). Revue des cultures coloniales 7(61):548-553.

HENDERSON, JUNIUS, and JOHN PEABODY HARRINGTON. 1914. Ethnozoology of the Tewa Indians. Bureau of American Ethnology Bulletin 56. Government Printing Office, Washington, D.C.

HENSHAW, H.W. 1890. Indian origin of maple sugar. American Anthopologist 3(4):341-351.

HOLMES, E.M. 1883-1884a. Vegetable tallow from Singapore. The Pharmaceutical Journal and Transactions. Third Series 14:401.

———. 1883-1884b. Essence of limes from Trinidad. The Pharmaceutical Journal and Transactions. Third Series 14:1005.

———. 1884-1885a. Lukrabo or TA-FUNG TSZE. The Pharmaceutical Journal and Transactions. Third Series 15:41.

———. 1884-1885b. Medicinal plants used by the Cree Indians, Hudson's Bay Territory. The Pharmaceutical Journal and Transactions. Third Series 15:302-304.

HORNADAY, WILLIAM T. 1889. The extermination of the American Bison. Annual Report of the Board of Regents of the Smithsonian Institution 1887, Part II:367-548.

HOUGH, WALTER. 1897. The Hopi in relation to their plant environment. American Anthropologist 10(2):33-44.

———. 1898. Environmental interrelations in Arizona. American Anthropologist 11(5):133-155.

HUNN, EUGENE S. 1977. Tzeltal Folk Zoology: The Classification of Discontinuities in Nature. Academic Press, New York, San Francisco, London.

JENKS, ALBERT ERNEST. 1898. The wild rice gatherers of the Upper Lakes: A study in American primitive economics. Annual Report of the Bureau of American Ethnology, Vol. 19, Part 2:1013-1137.

LASNET, DR. 1900. Notes sur la pharmacopée des Sakalaves du nord-ouest de Madagascar. Revue des cultures coloniales 6(49):171-175; 6(50):209-213; 6(51):233-238.

LAWRENCE, G. H. M. 1951. Taxonomy of Vascular Plants. The MacMillan Company, New York.

LeCOMTE, HENRI. 1897. Notre programme. Revue des cultures coloniales 1(1):4-5.

MASON, OTIS TUFTON. 1889. The Ray Collection from Hupa Reservation. Annual Report of the Board of Regents of the Smithsonian Institution 1886, Part I:205-239.

———. 1899. Aboriginal American zoötechny. American Anthropologist 1:45-81.

MATTHEWS, WASHINGTON. 1886. Navajo names for plants. The American Naturalist 20(9):767-777.

MEARNS, EDGAR A. 1896. Ornithological vocabulary of the Moki Indians. American Anthropologist 9(12):391-403.

MOONEY, JAMES. 1889. Cherokee plant lore. American Anthopologist 2(3):223-224.

———. 1891. The sacred formulas of the Cherokees. Seventh Annual Report of the Bureau of American Ethnology (1885-1886):301-397.

MURDOCK, GEORGE P. *et al.*. 1950. Outline of Cultural Materials. 3rd ed. Human Relations Area Files, Inc., New Haven, Connecticut.

MURRAY, STEPHEN O. 1982. The dissolution of "classical ethnoscience". Journal of the History of the Behavioral Sciences 18:163-175.

MUSÉUM IMPÉRIAL D'HISTOIRE NATURELLE. 1860. Instructions pour les voyageurs et les employés dans les colonies sur la manière de recueillir, de conserver et d'envoyer les objets d'histoire naturelle. Fifth edition. Imprimerie de L. Martinet, Paris.

PALMER, EDWARD. 1871. Food products of the North American Indians. Report of the Commissioner of Agriculture for the year 1870:404-428.

———. 1874. The berries of *Rhamnus croceus* as Indian food. American Naturalist 8(4):247.

———. 1878. Plants used by the Indians of the United States. The American Naturalist 12(9):593-606; 12(10):646-655.

PASO Y TRONCOSO, FRANCISCO del. 1883-1884. Estudios sobre la Historia de la Medicina en México. Anales del Museo Nacional de México 3(5):137-192; 3(6):193-235.

PERRIER DE LA BATHIE, H. 1902. L'élevage sur la côte ouest de Madagascar. Revue des cultures coloniales 11(104):1-5.

POWERS, STEPHEN. 1875. Aboriginal botany. Proceedings of the California Academy of Sciences 1873-1874 5:373-379.

———. 1975. Autobiographical sketch. Pp. 221-222 *in* The Northern California Indians. Stephen Powers. A reprinting of 19 articles on California Indians originally published 1872-1877. R.F. Heizer (editor). Contributions of the University of California Archaeological Research Facility 25. University of California, Berkeley.

RIDEAU, L.. 1901. Notes sur la culture et l'exploitation du cocotier dans la province de Binh-Dinh (Annam). Revue des cultures coloniales 9(82):76-82; 9(83):117-121.

ROCHEBRUNE, A.T. de. 1879. Recherche d'Ethnographie botanique sur la flore des Sépultures péruviennes d'Ancon. Actes de la Société Linnéenne de Bordeaux XXXIII (4ième série, t. III):343-358.

———. 1882-1883. De l'emploi des mollusques chez les peuples anciens et modernes. Revue d'ethnographie 1:465-482; 2:311-320.

ROSS, BERNARD ROGAN. 1861. An account of the animals useful in an economic point of view to the various Chipewyan tribes. Canadian Naturalist and Geologist 6:433-445.

———. 1862. An account of the botanical and mineral products, useful to the Chipewyan tribes of Indians, inhabiting the McKenzie River District. Canadian Naturalist and Geologist 7:133-137.

SÉBIRE, A. 1899. Les plantes utiles du Sénégal. Plantes indigènes — plantes exotiques. J.-B. Baillière et Fils, Paris.

STEARNS, ROBERT E.C. 1889. Ethnoconchology. A study of primitive money. Annual Report of the Board of Regents of the Smithsonian Institution 1887, Part II:297-334.

STICKNEY, GARDNER P. 1896. Indian use of wild rice. American Anthropologist 9(4):115-121.

THOMAS, N.W. 1900. Questions on animal superstitions. The Journal of the Anthropological Institute of Great Britain and Ireland 30, Anthropological Reviews and Miscellanea No. 114:114-116.

TRIMBLE, HENRY. 1888-1891. Some Indian food plants. American Journal of Pharmacy 60:593-595; 61:4-6, 556-558; 62:281-282, 598-600; 63:525-527.

WILSON, NORMAN L., and ARLEAN H. TOWNE. 1978. Nisenan. Pp. 387-397 *in* Handbook of North American Indians, Vol. 8, California. W.C. Sturtevant (editor). Smithsonian Institution, Washington, D.C.

Siren Feasts: A History of Food and Gastronomy in Greece. Andrew Dalby. Routledge, London and New York. Pp. xv; 320. US$55.95 (hardcover). ISBN: 0-4151-1620-1.

This book is not being marketed as an ethnobiological treatise, and thus there is real danger that ethnobiologists will miss it; I am writing this review to alert them. *Siren Feasts* is a genuinely indispensable work for anyone interested in the ethnobiology of Europe or the Mediterranean. It is up-to-date, scholarly, accurate, and thorough. It treats just about every plant, animal and mineral that the ancient Greeks ever thought to devour, and pays more than lip service to modern Greek ways as well. The book is definitely focused on Classical times, but it covers archaeology (with some important new information on the early Neolithic) and also Byzantine and modern times. It is a work of traditional scholarship; sources are described and evaluated with care, on the assumption that the reader will want to look at them. Among other things, Dalby has exhaustively searched through Greek plays (including some only recently rediscovered, as papyrus mss.) and carefully translated sections dealing with food.

Ethnobiologists will be especially interested in the chapter "Divine Inventions" (pp. 57-92), which provides a full list of Classical Greek foods with their Greek names. Most of the Greek names have come into service, in the last 300 years, as scien tific names. It is interesting to see how often the old names have been misapplied. The extreme case is *kaktos*, which originally referred to thistles. *Kardamon* originally referred to cress (presumably what we now name *Lepidium*). *Hamamelis*, which is now the scientific name of the witch hazel genus, then meant "wild apple."

The most interesting philological note, however, appears on page 182, where we learn that the Spanish *higado* and other Romance words for "liver" come from Latin *ficatus*, "stuffed with figs," which in turn was a translation gloss on Greek *sykoton*. The Greeks force-fed geese with figs to make the ancestral form of *pate de foie gras*, and the adjective applied to the resulting fatty livers is still with US.

Dalby's work is encyclopedic, not theoretical; it is a reference work. However, conclusions of wide interest do emerge, including the early emergence and great flourishing of gourmetship.

This book pairs usefully with Hellmut Baumann's recent book, *The Greek Plant World in Myth, Art and Literature* (1993). Baumann's book is less scholarly but has exquisite color photographs. It covers the wild plants, and thus forms a perfect complement for Dalby's coverage of the domesticated ones. Baumann addresses myths about wild plants, while DalLy covers the gastronomic literature.

To anyone who, like me, has some slight familiarity with Greece and wishes to know much more, these books are a true delight. All ethnobiologists should be aware of Dalby's book. No ethnobiological researcher or writer on European history or on the Mediterranean area can afford to ignore it.

LITERATURE CITED

BAUMANN, HELLMUT. 1993. The Greek Plant World in Myth, Art and Literature. Translated and augmented by William T. Stearn and Eldwyth Ruth Stearn. Timber Press, Portland, Oregon.

Eugene N. Anderson
Department of Anthropology
University of California, Riverside

Journal of Ethnobiology 18(2):189-209 Winter 1998

THINGS THAT GO *PO* IN THE NIGHT: THE CLASSIFICATION OF BIRDS, SOUNDS, AND SPIRITS AMONG THE NAGE OF EASTERN INDONESIA

GREGORY FORTH
Department of Anthropology
University of Alberta
Edmonton, Alberta
Canada T6G 2H4

ABSTRACT. — As an onomatopoeic name for 'owl', the Nage term ***po*** forms part of an ethnoornithological classification based primarily on visual criteria. It further denotes a class of nocturnal sounds attributed to owls, other raptorial birds, and certain inanimate objects. All entities able to produce these sounds are considered manifestations of malevolent spiritual beings. The essay explores relations among several classificatory schemes that include ***po*** and analyses the combination of perceptual and conceptual criteria on which they are based. It thereby addresses questions concerning connections between ethnozoological taxonomy and other classificatory schemes involving animal categories.

RESUMEN. — Como un nombre onomatopéyico para 'buho,' el término ***po*** del pueblo nage forma parte de la clasificación etnoornitológica basada principalmente en criterios visuales. Denota, más aun, una clase de sonidos nocturnos atribuidos a buhos, otras aves rapaces y ciertos objetos inanimados. Todas las entidades capaces de producir estos sonidos son consideradas manifestaciones de seres espirituales malévolos. El ensayo explora las relaciones entre varios esquemas clasificatorios que incluyen ***po*** y analiza la combinación de criterios perceptuales y conceptuales en la cual se basan. De esa manera retoma preguntas acerca de las conexiones entre la taxonomía etnozoológica y otros esquemas clasificatorios que involucran categorías animales.

RÉSUMÉ.— Le terme onomatopéique *po*, qui réfère au 'hibou' en langue nage, fait partie d'une classification ethnoornithologique essentiellement fondée sur des critères visuels. Le même terme dénote en plus une catégorie de sons nocturnes attribués aux hiboux, à d'autres rapaces et à certains objets inanimés. Toutes les entités capables de produire ces sons sont considérées comme des manifestations d'esprits malveillants. Cet article examine les rapports entre les divers systèmes de classification où apparaît *po* et analyse l'association des critères perceptifs et conceptuels formant leur base. Il traite ainsi de questions concernant les rapports entre la taxinomie ethnozoologique et les autres systèmes de classification impliquant des catégories animales.

The Nage, speakers of a Central Malayo-Polynesian language, are a group of about 50,000 cultivators and stock raisers who reside in the central part of the eastern Indonesian island of Flores.[1] Ethnographic and linguistic research conducted by the author indicates that Nage possess some sixty "basic" or "generic" (cf. Berlin, Breedlove, and Raven 1973) terms for birds, the majority of which refer to ornithological species. Only a few of these subsume less inclusive named kinds. One Nage bird name, the onomatopoeic ***po***, denotes owls. Other evidence reveals an association of this term with a more inclusive class focused on owls. Yet this

association complicates the status of ***po*** as an ethno-ornithological taxon, owing to the fact that the Nage term designates not only phenomenal birds but various nocturnal sounds. These sounds are also credited to birds other than owls and to things other than birds, thus defining an essentially mystical set of entities that 'can ***po***' (***ngala po***), that is, produce sounds designated as ***po***. Things other than birds that Nage describe as making these sounds include the trophy horns of sacrificial buffalo and certain manufactured items of ***hebu*** wood (*Cassia fistula*). At the same time, Nage believe that the sounds emanate ultimately from malevolent spirits; hence their classification of birds and sounds implicates a classification of spiritual beings.

The aim of the present exercise is to disengage the several referents of ***po*** and the classificatory domains in which they participate; to determine their perceptual and conceptual bases; and to consider how all these things may be connected. As it relates to birds, the essay bears on continuing debates about the nature of folk classifications of natural kinds, and particularly the issue of how far these are grounded in universal factors of perception and cognition relating to features of morphology and manifest behavior (e.g., Bulmer 1974; Hunn 1976; Atran 1990; Berlin 1992), as opposed to culturally specific considerations of utility (e.g., Hunn 1982; Randall and Hunn 1984; Ellen 1993). Proponents of the former position, sometimes identified as a form of "intellectualism," tend to advance a view of ethnobiological classification as fundamentally similar to modern scientific taxonomy. By contrast, their opponents stress the variety of classificatory forms in which folk categories denoting natural kinds can participate. Some intellectualists allow for the existence of special purpose classifications wherein folk biological taxa are ordered according to criteria that are culturally particular and non-perceptual (e.g., Berlin 1992; Hunn 1977:47). Yet the same authors consider such orderings as separate from and secondary to general purpose classifications, that is, taxonomic schemes grounded in the perception of natural discontinuities of morphology and behavior. Visual traits are most prominent among perceptual factors which intellectualists discern in the construction of folk biological taxa. Even in the case of birds, auditory features—their characteristic vocalizations—tend to be assigned a secondary place in the analysis of local definitions of natural kinds and for purposes of determining perceptual salience, although this tendency has recently been countered by Berlin and O'Neill (1981), who suggest that onomatopoeic names typically form a high proportion of the ethnoornithological nomenclature of small-scale and technologically simple societies (see also Forth 1996a:103).

Uses of the Nage word ***po***, one meaning of which is 'owl', support the intellectualist position insofar as the term can be shown to participate in an ethnoornithological classification quite distinct from other semantic domains in which the category is involved (see Forth 1996a). Available evidence moreover indicates that this classification is based primarily on perceptual, and indeed visual, criteria. Such is the case despite the onomatopoeic quality the word ***po*** shares with numerous other Nage bird names, and in spite of the fact that in other contexts ***po*** refers directly and exclusively to types of sounds. In this way, the present study illuminates the part played by visual and non-visual percepts in the con-

struction of ethnozoological taxa, in part by contrasting the significance of different sorts of sensory data in different cultural and linguistic domains. Simply to locate ***po*** among other Nage bird taxa, however, would distort its total meaning. For in addition to operating as a classifier of both birds and sounds, the term defines (though it does not precisely name) a symbolic or spiritual category of ***po***-sounding things. Being partly ornithological (insofar as it subsumes bird taxa included in Nage ethnoornithological classification) and partly non-ornithological (since it also subsumes material objects), this third category connects the avifaunal and auditory referents of ***po*** so as to compose a conceptual unity transcending the boundaries of distinguishable domains.

THE BIRD TERMS

As a reference to birds and sounds respectively, ***po*** forms two series of compound terms (see Table 1). Although distinguished from non-ornithological uses by the optional inclusion of one of three modifiers, the bird terms nevertheless designate what for Nage is an indivisible ethnoornithological taxon minimally labelled as ***po*** and glossable as 'owl'. In the sense of 'owl', ***po*** denotes a category subsumed by a covert grouping of 'birds' which in turn is included in ***ana wa***, a Nage term with the general meaning of 'animal' (see Forth 1995).[2] Intermediate between 'bird' and 'owl' (***po***), one may discern a "covert complex" (Berlin, Boster, and O'Neill 1981:99-100), or unnamed intermediate taxon, which might be glossed as 'night birds'.

Whatever the status of the latter in Nage thought, 'night birds' exists quite separately from a far more clearly circumscribed, although also unnamed, com-

TABLE 1. — Terms incorporating ***po***

(a) Terms denoting owls:	
Po koba	'vine ***po***'
Po kua	'eagle ***po***'
Po tadu	'horn(ed) ***po***'
(b) Terms denoting nocturnal sounds:	
Po polo	'witch ***po***'
Po bapu	'***bapu*** (malevolent free spirit) ***po***'
Po tadu bhada	'buffalo horn ***po***'
Po keo	'***po*** that sounds ***keo***'
Po uci	'***po*** that sounds ***uci***', 'whistling ***po***'
Po ci	'***po*** that sounds ***ci***', 'hissing ***po***'
Po lobo	'volcano ***po***'

Note on Orthography: Transcription of Nage words is based on standard Indonesian (Bahasa Indonesia). Most consonants are pronounced roughly as in English. The sounds written as /***bh***/ and /***dh***/ are implosives contrasting phonemically with /***b***/ and /***d***/. The /***c***/ (as e.g. in ***uci*** and ***céce***, Table 2) is pronounced as in English /chin/. All vowels are pure. The /***é***/ is a long 'e' (see ***céce***; cf. English "ail," but with a pure vowel), while /e/ represents the schwa between consonants (e.g. ***bele teka***, Table 2) and sometimes at the beginning of words (e.g. ***ema***, 'father'), and a long 'e' in the final position or in monosyballic words (e.g. ***céce***, ***je***, Table 2). Glottal stops are indicated with /'/ (see ***piko du'a***, Table 2).

TABLE 2. — Birds mentioned in the text with provisional identifications (for orthography see Table 1)

(A) Birds Regarded as Capable of Producing ***po*** Sounds	
Strigiformes:	
***po*(= *po koba, po kua, po tadu*)**	Eared owls, *Otus* spp. (probably including the Flores Scops-Owl, *O. alfredi*; Moluccan Scops-Owl, *O. magicus*; and Wallace's Scops-Owl, *O. sylvicola*) and the Barn Owl, *Tyto alba*
je	Brown Hawk-Owl, *Ninox scutulata*
Falconiformes:	
bele teka	Large falcons: The Peregrine Falcon, *Falco peregrinus* or the Australian Hobby, *Falco longipennis*
iki (or ***iki titi***)	A small falcon: probably the Moluccan Kestrel, *Falco moluccensis*
jata	Brahminy Kite, *Haliastur indus*
jata jawa	Larger hawks or goshawks: *Accipiter* spp. (Also named ***wole wa***)
kua (= ***kua méze***)	Eagles, including the Changeable Hawk-Eagle, *Spizaetus cirrhatus* and perhaps Bonelli's Eagle, *Hieraaetus fasciatus*
sizo	A small hawk or goshawk, *Accipiter* spp., perhaps the Chinese Goshawk, *A. soloensis*, or Besra, *A. virgatus*
Other:	
ana peti jata	White-headed Munia, *Lonchura pallida***
(B) 'Witch Birds' in Addition to Falconiformes and Strigiformes	
céce	drongo, *Dicrurus* sp. (probably the Wallacean Drongo, *D. densus*; Coates and Bishop 1997:409)
ha	Large-billed Crow, *Corvus macrorhynchus*
héga hea	Another species of *Corvus*, smaller than *C. macrorhynchus*; probably the endemic Flores Crow, *C. florensis* (Coates and Bishop 1997:415)
koa ka	Apparently a reference to the ***héga hea*** or the Common Koel (see below, regarding ***toe ou***), alternatively named after a nocturnal call of one of these birds
Night Birds Other Than ***Po*** or Other Witch Birds	
leba	Savannah Nightjar, *Caprimulgus affinus*
piko du'a	A quail (***piko***, *Coturnix* sp., probably *C. ypsilophora*) that calls at night
toe ou	Probably a reference to the Common Koel, *Eudynamys scolopacea*, otherwise named ***muta me***; "***toe ou***" resembles a nocturnal call of this bird (MacKinnon 1991:173)
tute péla	Pied Bush-chat, *Saxicola caprata* (not a night bird as such, but its nocturnal calling is regarded as an omen.)

** Following nomenclature employed by several authors for a fully white-headed Indonesian member of the genus *Lonchura*, I have previously given ***ana peti jata*** as *Lonchura maja* (Forth 1996a:105). This now appears incorrect. Coates and Bishop (1997:499; Plate 64), who use the name "Pale-headed Munia," list the endemic white-headed Wallacean species as *Lonchura pallida*, as does Verheijen (1963), who employs the English name "White-headed Munia."

plex of birds of the order Falconiformes, or diurnal birds of prey (see Forth 1996a). This is most clearly shown by the evidence of free recall lists, obtained from ten informants, mostly middle-aged or older and comprising eight males and two females, who were asked to give the names of all birds with which they were familiar, in any order they pleased. While listing birds they knew, most people thus mentioned names of Falconiformes — usually four or more in a cluster (see Table 2) — right at the beginning, whereas Strigiformes and other nocturnal birds they generally named much later. Only one of ten Nage listed 'owls' (***po***) in close proximity to names of Falconiformes. In fact, owls and other night birds were often initially overlooked in free recall, and were later named only in response to prompts (e.g., "Do you know any birds that are active at night?"). When talking (and thinking) in a general way about birds, therefore, Nage not only separate Falconiformes from Strigiformes, they also tend to treat the diurnal raptors as the most typical members — a focus or prototype — of the unlabelled life-form taxon of 'bird'. (Other highly salient bird kinds, mostly coinciding with a series of unnamed intermediate groupings, are described in Forth 1996a:96-99, 108.) As night birds, owls are clearly peripheral to this life-form taxon.

This separation of daytime from nighttime birds of prey is important, for as I presently show, in another kind of discourse ***po***, understood mostly in a verbal sense and as referring to vocal capabilities, defines a class of birds and other things which includes both nocturnal and diurnal raptors. What is more, while daytime birds of prey are unequivocally central to the category of 'bird', and while night birds, including owls, are peripheral, in this other context, the relation is inverted. It is owls that occupy the more central place.

Also crucial to this contextual contrast is the circumstance that half of the Nage who provided recall lists grouped owls with other night birds that do not belong to the mystical or spiritual category of things believed to produce ***po*** sounds. Conversely, none of these informants identified eagles, hawks, or falcons as 'night birds', even though diurnal raptors too are reputed to emit nocturnal sounds classified as ***po***. Nocturnal kinds which Nage say "do not ***po***" (***mona po***) include the Savannah Nightjar (***leba***), the birds named ***toe ou***, ***koa ka***, and ***piko du'a*** (see Table 2), and several kinds of bats (which, with qualifications, Nage classify as birds). All this attests to a perceptual, and more specifically visual, basis for Nage ethnoornithological classification, insofar as it indicates that Falconiformes are separated from Strigiformes by virtue of visible, behavioral features, and particularly the fact that they are seen flying during the day. By the same token, by separating night birds from day birds, in their construction of a general classification of avifaunal kinds Nage evidently do not attach significance to a bird's supposed ability to produce ***po*** sounds.

the three synonymous terms that Nage apply exclusively to owls (listed in Table 1) are ***po koba***, ***po tadu***, and ***po kua***. In each case the second element modifies ***po***, which is understood as a substantive. As ***koba*** means 'creeping or climbing plant, vine', Nage explain this as an allusion to the common sighting of owls perched on or near large forest vines during the daytime. ***Po tadu***, 'horn(ed) po', refers to the 'horns', or 'ears', some owls are recognized to possess. According to Nage consultants, the name ***po kua*** is motivated by the resemblance in plumage

between owls and eagles (***kua***, or ***kua méze***), although conceivably other similarities between the two bird kinds might play a part as well.

It is important to stress that these three modifiers refer not to different species of owls, but rather to features of what Nage regard as a single kind. Although there appear to be three or four owl species present in Nage territory, including both eared owls (Strigidae; mostly of the genus *Otus*) and Barn Owls (Tytonidae),[3] Nage deny with quite remarkable consistency that the three terms distinguish three distinct owl kinds, describing them instead as alternative names for the same bird which focus on different physical or behavioral features.[4] While Nage are aware that not all owls possess 'horns', some explain these as possibly a sexual characteristic — speculating that only the males are horned — rather than as a trait marking a separate owl kind. The synonymy of the three names is further indicated by the remark of one man, who referred to owls as ***po kua*** ('eagle ***po***') but immediately added that these are recognized, and distinguished from eagles (***kua***), by their 'horns'.[5]

The term for 'owl', ***po*** is an onomatopoeic name, replicating a nocturnal vocalization that Nage identify as one of a number of sounds characteristically produced by owls. Owls are counted as one of several birds Nage describe as "saying their own name." Following Jespersen's strict definition of onomatopoeia, ***po*** can further be characterized as an "...echoic word (which) designates the being that produces the sound" (1921:399; cited in Berlin and O' Neill 1981:239). As is often the case with such names (cf., English "crow" and "cuckoo"), ***po*** further refers to the sound itself, or rather, in the Nage case, to a series of sounds so classified, and to the act of producing the sound or sounds.

As noted, however, Nage claim that not only owls (***po***) are capable of producing sounds they classify as ***po***, since they consider a number of other raptorial birds, and even certain material objects, as capable of doing so as well. With one exception, other birds credited with this ability are diurnal birds of prey. All of these are separately named, and none is designated with a name incorporating the lexeme ***po***.[6] Among these are eagles, the Brahminy Kite, large and small hawks, and two kinds of falcon. The one non-raptorial bird sometimes classified as a ***po***-sounder is the White-headed Munia, called ***ana peti jata***, or 'Brahminy Kite Munia', so named because its plumage closely resembles that of the rusty-red white-headed Brahminy Kite (***jata***). The inclusion of this little bird among kinds that produce ***po*** sounds provides one indication of the significance of visual, and morphological, criteria in defining the otherwise auditory category, a matter I take up further below. It is similarly noteworthy that some informants doubted whether the munia can really produce ***po*** sounds, adducing its small size — thus another visual criterion — as the reason for their sceptism.

Curiously, some Nage were also unsure whether another raptorial bird, and moreover a strigiform, is able "to ***po***. This is the ***je***, which, judging from local descriptions, is the Brown Hawk-Owl (*Ninox scutulata*). The status of this bird in relation to the category of things that manifest ***po*** sounds is thus somewhat ambiguous. Nevertheless, the fact that ***je***, when mentioned in free recall, was most often listed with ***po*** provides further evidence that, in this classificatory context, the night birds are grouped primarily on the basis of visual criteria (morphology

and observable behavior) rather than their common membership in the auditorially conceived mystical category.[7] The ***po***-sounding birds, as they may be called, together with provisional scientific identifications, are listed in Table 2.

Since Nage do not normally speak of raptorial birds other than owls as 'kinds of ***po***',[8] when used as a substantive ***po*** does not unambiguously designate a class of birds, or other entities, that can produce ***po*** sounds. At the same time, all things thought to emit these sounds can be said to constitute a covert grouping, which is to say, one unnamed by any single lexeme. What is more, for Nage this grouping and the category named ***po***, denoting Strigiformes, are conceptually close. As the epitome of things that produce ***po*** sounds, owls constitute the focus of the unnamed class. Pertinent here is the fact that Nage claim only to have seen owls actually making the sounds. The idea that other birds can do so as well, while maintained with considerable conviction, is therefore not well grounded in experience. As one man expressed the matter, it may simply be an 'inference' or 'interpretation' (Indonesian *tafsiran*).

Insofar as reputed ***po***-sounding birds other than Strigiformes are, with one exception, all diurnal raptors, the fact that owls are nevertheless the prototype points to another peculiarity of the unlabeled class. It accords with the inversion mentioned just above, of the normal pattern whereby creatures of the daytime are considered typical and unmarked, while night creatures are atypical and marked. The obvious ground for this pattern is the fact that diurnal creatures are more often seen and therefore far more familiar than are night creatures (cf., Bulmer 1979:67). In the present case, however, the inversion can be understood as confirming the primacy of auditory over visual values in the classification of entities linked with the category ***po***.

THE *PO* SOUNDS

The third use of ***po*** concerns a series of names incorporating this term which designate sounds heard at night (see Table 1, above). Formally speaking, the series is identical to the set of three names that denote birds. However, whereas the latter all refer synonymously to a single ethnoornithological category, the sound terms distinguish several varieties of nocturnal vocalizations. Since all of the named ***po*** sounds are thought to be made by all of the entities Nage credit with the ability "to ***po***," there is no systematic matching of types of ***po***-sounding birds with kinds of ***po*** sounds.[9]

All of the ***po*** sounds are regarded as portentous, particularly when encountered near habitations. Two of these — ***po polo*** and ***po bapu*** — refer more specifically to sounds that manifest different kinds of spiritual beings. ***Polo***, the first modifier, means 'witch' and refers to a person believed to operate as a maleficent spirit, attacking human victims by mystical means, typically at night. Although ***polo*** thus refers to a type of human being as well as to a malevolent spiritual force, witches are distinguished from other humans on specifically spiritual grounds; hence ***polo*** can be treated as a kind of spiritual being. Also relevant in this connection is the fact that Nage sometimes speak of ***po*** — referring both to sounds and birds — as a form assumed by the ***wa***, the maleficent spirit, of a witch (see Forth 1993a).

The term ***bapu***, another modifier of ***po***, denotes varieties of malevolent autochthonous free spirits associated with uninhabited places. ***Polo*** and ***bapu*** are very closely related concepts in Nage cosmology, in part because some ***bapu*** spirits are regarded as the source of a witch's powers (see Forth 1998). Nevertheless, the spiritual entities to which the terms refer are distinct. Accordingly, ***po*** sounds identified with each, though equally inauspicious, are distinguished by different auditory qualities. Sounds identified as ***po polo*** ('witch ***po***') include an uneven number of 'soft' or 'weak' calls. Another manifestation is a call heard coming from the ground at night, just in front of a house or beneath a raised house floor, indicating that a witch is extremely angry at someone living in the house. Such an event is taken to foreshadow certain disaster unless ritual measures are taken to ward off the witch's wrath.

Calls are interpretable as ***po polo*** by their number. Thus a ***po*** sound repeated eight times can indicate an imminent theft. An informant from the Keo region, to the south of Nage, stated that ***po*** repeated four times is a bad omen for one's own group, while five times means that the bad news is for 'other people'. Although consistent with the auspicious and inauspicious significance both Nage and Keo attach to odd and even numbers respectively (see Forth 1993b), this notion appears inconsistent with the Nage representation of ***po polo*** as comprising an uneven number of cries. The same informant further stated that a harsh call is an omen for men whereas a soft call is ominous for women.

Sounds classed as ***po*** are not invariably interpreted as omens. In fact, they are heard so often at night that they acquire determinate mystical significance mostly situationally, for example when they are heard unusually close by, or repeatedly, or when they occur in conjunction with other sorts of inauspicious signs or unfavourable circumstances. Describing the auditory phenomenon known as ***po uci***, one Nage man suggested that, whereas a combination of ***po*** and ***uci*** sounds (which I describe just below) indicate the presence of a witch, ***po*** sounds heard alone might be nothing more than the nocturnal cry of a bird. More often than not, however, Nage identify ***po*** sounds as portents that are at least potentially inauspicious. What is more, they usually take them to indicate the presence of a witch (***polo***), even to the extent that ***po polo*** can be characterized as the prototypical variety of all ***po*** sounds.

In contrast to ***po polo***, Nage describe ***po bapu*** ('malevolent free spirit ***po***') as a loud, penetrating cry that carries far, often taking the form of a series of long, drawn-out or continuous hoots. Occasionally, I recorded ***po bapu*** as a reference not simply to a sound but directly to a ***bapu*** spirit, a usage that is fully in accord with a close connection between ***po*** sounds and malevolent spiritual forces generally. Sometimes Nage further distinguish a particular variant of ***po bapu*** called ***po tadu bhada***, 'buffalo horn ***po***'. This refers to a representation of sacrificial water buffalo as embodiments of mountain-dwelling spirits, also classified as ***bapu***, which continue to be identified with the trophy horns of slaughtered buffalo (Forth 1989). Nage describe this buffalo horn ***po*** as a soft, faint noise like a 'puff' or quiet 'pop'. When such a sound is heard, a fowl should be slaughtered and some of its blood smeared on the horns in order to avert illness or other misfortune, as the sound is taken to mean that the trophy horns have not been properly cared for. Nage regu-

larly speak as though the buffalo horn ***po*** emanates directly from old trophy horns. On the other hand, one informant explained that the sound was more likely produced by a bird calling just outside a building in which horns are stored. This sort of disagreement may indicate that, unlike birds, and especially owls, material objects are marginal to the set of entities that Nage say "can ***po***." Nevertheless, one cannot on this ground simply exclude them from the unlabeled grouping, any more than one can distinguish sharply between nocturnal and diurnal birds in this context.

In contrast to the buffalo horn ***po***, the other sort of ***po bapu*** sound — the common or unmarked variety — is often interpreted as a sign that a ***bapu*** is demanding that a human client reciprocate favors bestowed by the spirit. A particularly famous spirit of this sort inhabits a large boulder called ***Ebu 'Egu*** (see Forth 1998); hence its auditory manifestation is sometimes specified as ***po Ebu 'Egu***. Nage further associate ***po*** sounds, and more particularly ***po bapu***, with the ***hebu*** (*Cassia fistula*), a hardwood tree possessing an especially powerful ***bapu*** spirit. Should anyone build a house or field hut close to such a tree, the occupants are likely to be constantly bothered by ***po*** sounds. Also relevant in this connection is the use of ***hebu*** wood in the construction of forked sacrificial posts (***peo***), wooden statuary (***ana deo***), and the principal post, or 'hearth post' (***posa lapu***), of special ceremonial buildings, or 'cult houses' (***sa'o waja***). All of the foregoing are items of ritual importance which, if not treated properly, can similarly express their anger by way of ***po*** sounds.

Also illuminating the common association of objects of ***hebu*** wood and buffalo horns with the auditory category ***po*** and the spiritual category ***bapu*** is the use of forked ***hebu*** posts (***peo***) for tethering sacrificial buffalo. In addition, wooden statues and house posts of ***hebu*** are exclusive to cult houses, buildings in which trophy horns are also found. Not surprisingly, therefore, the sound of ***po bapu*** heard repeatedly near a cult house is thought to reflect the displeasure of a ***bapu*** spirit — in this context represented as a negative component or aspect of the otherwise tutelary 'house spirit' (***ga'e sa'o***) — caused by the house owners' having allowed the building to fall into disrepair or having transgressed rules of proper use. Nage commentators mostly linked ***po bapu*** in these circumstances with the ***hebu*** wood used to construct such a house. Nevertheless, the connection with buffalo horns, which Nage also identify with the guardian spirit of a cult house, is equally germane in this setting.

The association of ***po*** sounds and buffalo horns may recall the term ***po tadu***, 'horn(ed) ***po***', as a specific reference to owls. However, neither trophy horns nor sounds called ***po bapu*** are associated with any particular kind of bird. Rather, buffalo horns, the ***hebu*** tree, all ***po*** sounds, and all ***po***-sounding birds figure as components of an intricate representation of the two named varieties of malevolent spirits, ***bapu*** and ***polo***. A further idea connecting ***bapu*** with both buffalo and raptorial birds is the belief that the ***bapu*** spirits that reside atop the volcano Ebu Lobo assume the guise of a Brahminy Kite (***jata***) or a large, high-flying hawk (***jata jawa***) when searching for human victims, whom they characteristically kill in the form of spirit buffalo. In contrast to the general pattern, in this instance a particular kind of spirit is indeed identified with a particular bird taxon (the diurnal raptors

classified, specifically or generically, as ***jata***). Yet in this case it appears significant that the manifestation is not auditory but visual, a contrast to which I return later.

In addition to ***po polo*** and ***po bapu***, Nage recognize two other types of ***po*** sounds: ***po keo*** and ***po uci***. In these instances the modifiers of ***po*** are onomatopoeic references to auditory phenomena rather than the names of spirits. Each kind of sound can accordingly be designated simply as ***keo*** or ***uci***. Even so, ***po keo*** and ***po uci*** are equally regarded as manifestations of both malevolent spirits (***bapu***) and witches (***polo***). ***Po keo*** describes a harsh cry reproduced as *"keo, keo,"* or as *"ko, ko, ko, ko, ko, keo."* Unlike other ***po*** sounds, Nage consider this a partly auspicious omen. Heard in the night before the annual hunt (***to'a lako***), ***po keo*** indicates that wild pigs, or other large game, will be killed on the following day.[10] Although mostly regarded as a simple augury — and a positive one at that—a link between ***po keo*** and ***bapu*** spirits is nevertheless discernible in the belief that spirits of ***hebu*** trees can manifest themselves as wild pigs, as well as in the idea that nature spirits generally are the owners of game animals. This latter belief also helps explain why the ***keo*** sound is sometimes regarded as auspicious. Although it may manifest potentially harmful free spirits, it does so in a way that reveals the presence of their livestock, which humans wish to appropriate. The cry of ***keo*** at other times can reveal a witch (***polo***) out hunting for human victims, another notion connecting ***po keo***, like other ***po*** sounds, with spiritual malevolence. In this regard, the auspiciousness of the ***keo*** sound during the annual hunt might further be attributed to the fact that, on this single occasion, human hunters — sleeping outside in the wild, staying awake until late into the night, and attacking and killing, if not wild spirits, then their livestock — themselves resemble man-hunting witches.

The other major category incorporating ***po*** and referring to ominous nocturnal sounds is ***po uci***. Though ***uci*** refers to a high-pitched whistle, Nage speculate that the sound may be produced by a bird's wing rather than by vocal means. Placed after ***po***, ***uci*** can be construed either as a modifier or as a term paired with the former, the two words in combination — and in accordance with a dualistic pattern of nomenclature widespread in Nage (Forth 1996b) — referring in a more general way to inauspicious nocturnal sounds. As accords with the second interpretation, ***uci*** is sometimes heard in combination with vocalizations more specifically classified as ***po***, that is, the hoots and other softer calls usually distinguished as ***po bapu*** or ***po polo***.

That the sounds sometimes occur in succession of course suggests that ***po*** and ***uci*** derive from the same bird. In one instance, several Nage reported hearing the ***uci*** sound repeated three times followed by a double cry of ***po***. This was heard close to the grave of a man who had died ten days previously, and was counted as one of several indications that he had been killed by a witch. Whether or not the sounds occur in succession, ***uci*** is attributed to exactly the same birds that give voice to other ***po*** sounds. Some local interpretations link the sound more closely with diurnal raptors (the Brahminy Kite and eagles being mentioned most often in this connection) than with owls, an association that may seem curious in view of the coupling of the ***uci*** sound with ***po*** and the especial, though not exclusive, linking of ***po*** with owls. One man, for example, said he could not be sure whether

owls could "***uci*** as well as ***po***," but he was certain that kites, eagles and falcons (***jata***, ***kua***, and ***iki***; see Table 2) could do so. A possible complementary association may be found in evidence which, although not conclusive, suggests that ***po keo*** is mostly associated with owls rather than with diurnal birds of prey. Whatever is to be made of this, all Nage regard ***uci***, like the ***po*** sound, as a manifestation of a malevolent being, and most often, if not invariably, of a witch (***polo***).

Further possible distinctions among ***po*** sounds are signalled with the terms ***po ci*** and ***po lobo***. Some Nage distinguish ***po ci***, a reference to a hissing or rasping sound ("*chhh*" or "*shhh*") reminiscent of sounds made by the Tytonidae, from the high-pitched whistle they call ***uci***. Yet they attribute the same mystical significance to both. People in the Keo region mentioned ***po lobo***, roughly 'volcano ***po***', as the cry of a night bird that begins as a small, soft voice that gets progressively louder. Although I never encountered this category among Nage, it nevertheless accords with other Nage representations of raptorial birds. For Keo say this ***po lobo*** manifests a being from the Ebu Lobo volcano out searching for buffalo, which is to say human victims, and thus reveals a spirit of the sort Nage classify as ***bapu***.

As the foregoing makes clear, whereas ***uci*** and ***keo*** refer to quite specific sounds, ***po*** denotes a wide variety of bird vocalizations. Yet as an onomatopoeic term, ***po*** reproduces only particular instances of this class. Thus it may be understood as a synecdoche and a prototype of a more inclusive auditory category, paralleling the prototypical status of owls in relation to the entire class of birds and other things thought capable of producing the ***po*** sounds. Although, among birds, only owls are unambiguously denoted by ***po***, this formal similarity provides an important clue to the association of the onomatopoeic term, and the sounds it designates, with the larger, mystical category of ***po***-sounding entities.

As further accords with the special connection between ***po*** sounds and owls, Nage speak of the sounds (including ***uci*** and ***keo***) as the only calls made by Strigiformes. By contrast, they recognize diurnal birds of prey as producing vocalizations other than ones classified as ***po***. Unlike ***po*** sounds, these cries are normally heard during the daytime. For this reason, and because they are not considered ominous, they do not in themselves connect the birds with malevolent spirits. The Kestrel (***iki***), for example, cries "*ki ki ki ki*," as, following some accounts, does the falcon named ***bele teka***, which also emits an ascending "*wiiii*." The term ***ie*** refers, onomatopoeically, to a call of kites (***jata***), though it further denotes the whinnying of a horse (cf. also ***ie wea***, the Hill Myna, *Gracula religiosa*). The high-pitched shriek of eagles (***kua***) sounds something like "*ji ji ji jiii*" according to several informants. In addition, Nage employ a special term, ***noi***, to refer to the crying of eagles, but this appears not to be onomatopoeic.

Also worth mentioning in this context is ***manu miu***, another auditory category possessing mystical significance. Although ***manu*** is '(domestic) fowl', most Nage explain the name not as a reference to a physical bird, but to a sound resembling the second person plural (***miu*** 'you'). Always heard in the night, the sound is attributed to horses as well as to small birds, kites, and eagles. While I have never heard it associated with owls (***po***), Nage claim that the sound, or what makes the sound, is 'commanded by witches' (***polo watu***). Upon hearing 'you' uttered in the nighttime, therefore, people should at all costs refrain from replying "who are

you?," as this could result in the deaths of the questioners or their kin. Like ***po***, then, ***manu miu*** is a term, partly ornithological in reference, which denotes a dangerous nocturnal sound identified with a malevolent spirit. Yet, unlike ***po***, it refers to a vocalization that portends misfortune only when it evokes a particular response. Also, in the majority view, the term does not simultaneously name a physical, or potentially visible, bird.

ANALYSIS

Thus far we have seen how ***po*** denotes both owls and a series of sounds, at least some of which are imitated by the word. In both contexts, the term can be called onomatopoeic. Yet the first, ornithological sense of the term is distinguished by modifiers which refer not to sound, but to visible features of physical birds (see Table 1 above). On the other hand, sound figures crucially in defining the mystical category of birds and other things that 'can ***po***'. As shown, owls — the only birds that Nage straightforwardly designate as ***po*** — are the most central members of this grouping, just as they are the sole members of the ethnoornithological taxon of the same name. In addition, it is on the whole nocturnal Strigiformes, rather than diurnal Falconiformes, that are more closely associated with the several separately named kinds of ***po*** sounds as well as with the malevolent spiritual beings considered their ultimate source.

As demonstrated, the central position of owls in all three contexts owes something to auditory experience. Nage claim to have seen Strigiformes emitting ***po*** sounds, while the idea that other birds can do so is an inference. At the same time, the fact that the sounds are heard at night means that their producers cannot normally be seen; hence their possible attribution to a variety of otherwise visible things, including what westerners would regard as inanimate objects as well as diurnal raptors. What has yet to be considered, however, is why Nage should think that diurnal birds of prey also make sounds empirically attributable only to owls. The answer requires consideration of factors additional to actual vocal properties, that affect the focality of owls within the several classificatory domains in which ***po*** participates.

While ***po*** strictly speaking names only owls and sounds, crucial to a proper understanding of its function in defining a wider class of perceptible things is a third term connecting birds, material objects, and auditory phenomena in a way that, for Nage, creates a unitary configuration of meaning. This third term is malevolent spirits. All physical things associated with ***po*** sounds, whether birds or material objects, are considered by Nage as visible, or potentially visible, manifestations of dangerous spirits. Also, while Nage statements sometimes suggest that the sounds are produced by birds serving as physical media of witches and ***bapu*** spirits, other evidence indicates a representation in which the sounds, on the one hand, and visible birds and objects, on the other, are equally signs of malevolent anthropomorphic beings which are spiritual and hence essentially invisible.

Consistent with the second interpretation are occasional Nage claims that ***po*** sounds, inasmuch as they manifest the anger of spiritual beings, are not made by birds at all. Here one is reminded the remark of Feld's Kaluli informant, who as-

serted that what westerners call birds, New Guinean Kaluli regard as ancestral voices (1982:45).[12] The Nage statement might be understood simply as a claim that spirits, not birds, are the ultimate source of the sounds. Yet it also suggests a distinction between sounds whose derivation from the mouths of birds, if not incidental, is of secondary significance, and physical birds that can be conceived non-spiritually. The distinction of course accords with evidence suggesting that Nage conceive of owls and other ***po***-sounding birds in two quite separate ways: as components of an ethnoornithological taxonomy based on visible features, and as focal members of an unlabelled mystical grouping defined by auditory phenomena ineluctably associated with — and simultaneously attributed to — malevolent spiritual beings. In this connection, Nage statements regarding ***po*** bear comparison with remarks by Geddes on the Fijian association of guardian spirits called "*vu*" (possibly cognate with the element ***pu*** in Nage ***bapu***) and a bird called "*kikau*." The spirit, Geddes claims, "is not considered to be resident in the *kikau* nor even that the *kikau* signals his presence [*sic.*]. It is merely that the sound is identical" (1945:43).

While the mystical class of ***po***-sounding entities is defined by sound, and particularly sounds known to be produced by owls, other members, especially daytime birds of prey, are evidently included on the basis not of auditory, but of visual (that is, morphological and behavioral) features, the principal bases of Nage ethnoornithological taxonomy. This is not simply to say that, on objective, empirical grounds, diurnal raptors sufficiently resemble owls to be classed with the onomatopoeically designated nocturnal raptors. For local ideas regarding malevolent spirits appear inextricably bound up in this relationship as well.

Diurnal raptors participate in representations of murderous witches and malevolent ***bapu*** spirits largely by virtue of their predatory and carnivorous habits combined with their possession of sharp bills and talons. Relevant here is the Nage characterization of all flesh-eating birds — scavengers (e.g., the crows named ***ha*** and ***héga hea***) as well as predators — as *burung suangi*, an Indonesian phrase meaning 'witch birds'.[13] Also included in this grouping are the drongo (***céce***) and a bird named ***koa ka*** (see Table 2 above). While drongos occasionally eat flesh (MacKinnon 1991:250), like the crows both birds are further identifiable with nocturnal witches and spirits by virtue of their dark plumage, and in their different ways both are considered birds of ill-omen.[14] The ***koa ka*** is moreover known only by its nocturnal cry, while the drongo is especially threatening when it calls after sunset. Clearly, then, the Nage class of 'witch birds' is more inclusive than the group of ***po***-sounding birds, a category which (with the obvious exception of the White-headed Munia) applies only to predators. On the other hand, non-birds which also 'can ***po***' are obviously not included among the 'witch birds'. The relation between 'witch birds', nocturnal and diurnal raptors, and other physical entities Nage identify with ***po*** sounds is illustrated in Figure 1.

While 'witch birds' are largely defined by visual features (including plumage and diet), ***po***-sounding birds are nevertheless more central to the class than are other kinds. Especially diurnal birds of prey share a definitive behavioral trait with witches, and in a sense with anthropomorphic ***bapu*** spirits as well. This is their habit of killing and eating other birds, most notably domestic fowls, a char-

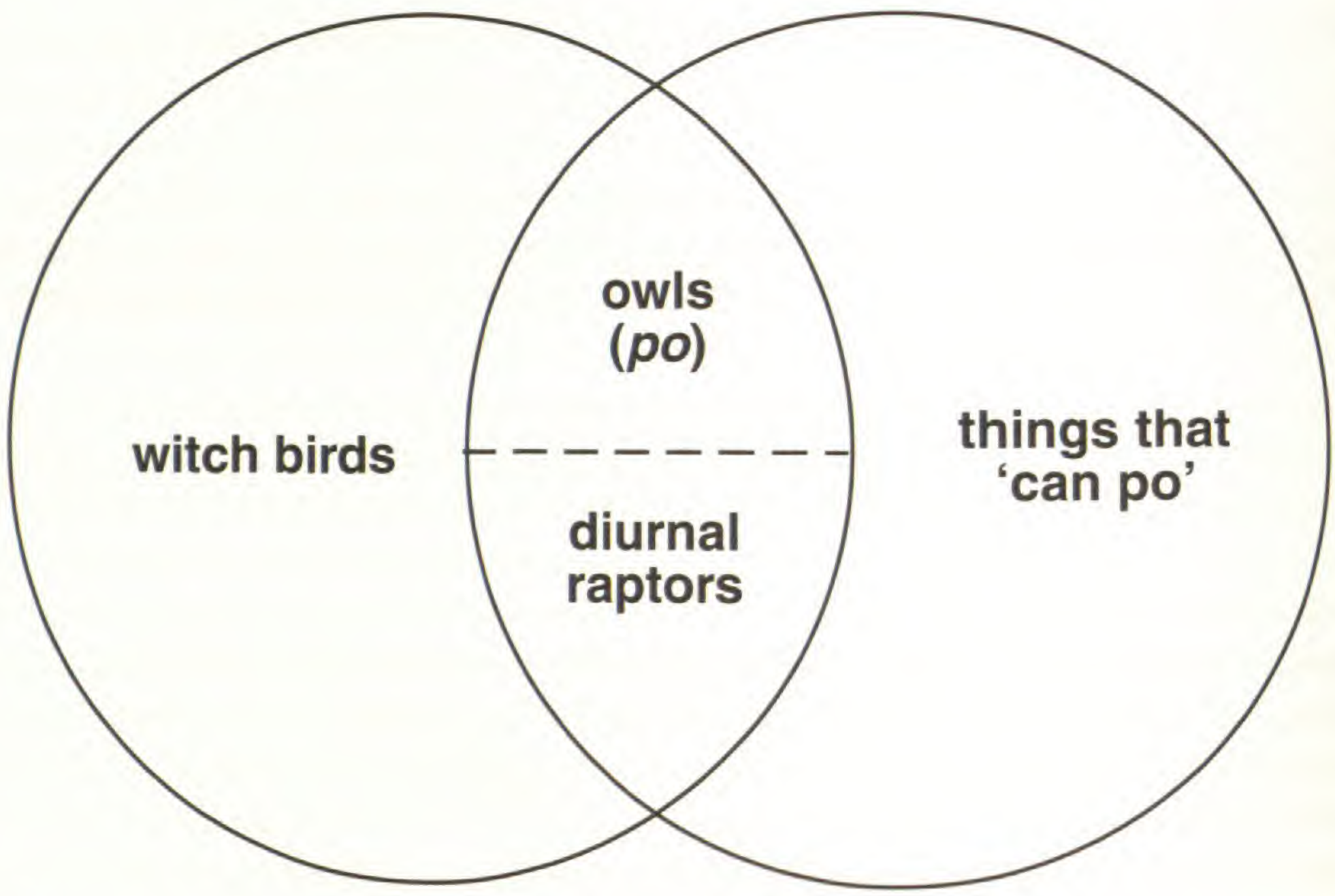


FIGURE 1. — Witch birds and things that produce ***po*** sounds

acteristic that parallels the anthropophagous proclivities of Nage witches (Forth 1993a). Owls are generally less given to preying on other birds than are Falconiformes. Yet in other respects the nighttime predators are even more closely linked with witches and ***bapu*** spirits. Apart from their nocturnal habits, owls alone possess visible features which, in Nage thought, associate them with the malevolent anthropomorphic spirits. Relevant here is the ability of witches and ***bapu*** to manifest themselves as a variety of creatures, and to partake of both human and animal characters. As Nage frequently observe, the round facial discs of the Strigiformes resemble human faces. They also describe the form of the birds' heads, and especially their "ears" (or 'horns'), as lending them the appearance of cats, an evaluation suggesting that they are birds which, rather anomalously, exhibit features of non-birds.[15] Yet another connection is the reputed ability of human witches, in accordance with their generally inverted character, to rotate their heads 180 degrees, just as owls are known to do.

Although owls (***po***) are clearly the prototype of the complex of things associated with the auditory category labelled ***po***, the identification of Strigiformes with witches and ***bapu*** spirits thus appears to derive in considerable measure from visual features. Sharing several of the latter with Strigiformes, diurnal birds of prey are then assumed by Nage to share also in the vocal habits of both owls and maleficent spirits (cf., Lakoff 1987:86, citing Rips 1975). With objects such as buffalo horns and things made of ***hebu*** wood, the spiritual connection is rather more ideological than perceptual or empirical. Yet it is evidently sufficient to associate these material objects with owls (and hence with other raptorial birds) as things that 'can ***po***'. This circumstance moreover confirms how an identification with malevolent spirits provides the common link among all things, birds and non-birds and nocturnal as well as diurnal avifauna, belonging to the class of ***po***-sounding entities.

While an identification of ***po*** sounds with witches and other harmful spirits is crucial to the inclusion of diurnal raptors in the class of ***po***-sounding things, there remains the question of the origin of the identification itself. Occasional experience of the sound emanating from physical birds whose form reminds Nage of malevolent spirits would seem an inadequate explanation. An additional factor may therefore be the nature of the sounds themselves, including inherent qualities of eeriness or mystery. In this regard, Nage ideas about ***po*** may lend support of the thesis of an inextricable link between particular kinds of sound and varieties of experience contributory to the development or maintenance of spiritual or religious representations (see Tuzin 1984). Recalling that spirits the world over tend to be conceived as essentially invisible (or, at least, bound to no particular visible form), also relevant here are the views of Walter Ong concerning the "interiority of sound" and the "exteriority of vision," and the special relation of the former to what Ong calls "the sacral"(1982:71-75).

Although pertaining more to features of language than directly apprehended sound, a resemblance between ***po*** and ***polo*** ('witch'), a non-onomatopoeic term with a quite separate derivation (cf. Malay *polong*, meaning 'evil spirit'), may also contribute to an evaluation of ***po*** sounds as manifestations of spiritual malevolence. Similarly suggestive in this regard is the homonym ***po*** ('to cut, to be cut down'), which in the idiom ***mata po*** (***mata*** 'to die') specifies a premature death. Not only is this a frequently cited form of retribution by witches and other angry spirits, but an untimely death is also a possible consequence of failed attempts to derive special powers from ***bapu*** spirits, an alternative outcome of which is transformation into a witch (***polo***). A similar interpretation may apply to ***keo***. Although I have no record of comparable senses in Nage, included among meanings of the cognate employed by the neighbouring Ngadha are 'to cut off, through' and 'to determine (fate), prophesy, preordain' (Arndt 1961:238 s.v. ***kéco***). Thus, in addition to their inherent qualities, the Nage identification of ***po*** sounds with witches and other harmful spirits may owe something to their resemblance to human words and voices, particularly as they issue from a nocturnal, invisible — and seemingly disembodied — presence.

CONCLUSIONS

The foregoing discussion supports several conclusions. In the sense of 'owl', Nage ***po*** figures as a relatively peripheral taxon in an ethnoornithological classification based primarily on visual criteria, of which diurnal raptors are among the most focal members. Conversely, owls are central, and day birds relatively marginal, to the category of ***po*** understood as a reference to a series of nocturnal sounds and as the defining quality of a spiritual class. Thus when auditory values are valorized over visual ones, the taxonomic precedence of diurnal over nocturnal birds is overturned.

Although owls and other raptors are conjoined as instances of ***po***-sounding birds, this obviously does not constitute a discrete ethnoornithological taxon since it is subsumed within a broader spiritual class that further includes ***hebu*** trees, things fashioned from ***hebu*** wood, and buffalo horns. By the same token, the seem-

ingly heterogeneous composition of the spiritual category can hardly be adduced in support of the view that folk classifications of natural kinds are radically different from scientific taxonomies or display considerable cultural relativity. Nage do employ an ethnoornithological classification, yet it exists quite separately from the symbolic complex in which ***po*** figures as a spiritual or mystical category.

While the series of ***po*** sounds and various entities thought to manifest these sounds are connected by their common link with powerful spirits, spiritual associations play little if any part in Nage ethnoornithological taxonomy. Although several, mostly diurnal birds with dark plumage are identified as 'witch birds', their coincident association in folk ornithology (Forth 1996a: 108) appears to turn on this salient visual feature rather than on any auditory or other similarities (such as dietary habits or nocturnal behavior) that further identify them spiritually. Separating ***po***-sounding night birds from ***po***-sounding day birds, Nage bird taxonomy is grounded in perceptual criteria that reflect natural discontinuities which are largely independent of culture. In contrast, as ominous manifestations of spiritual malevolence evoking ritual or other responses that in a general sense can be called practical, the class of ***po*** sounds and the entities with which they are associated are culturally quite specific, and are arguably bound up with utilitarian considerations such as avoidance of illness and other misfortune.

That beliefs regarding which birds produce ***po*** sounds have no direct bearing on Nage ethnoornithological taxonomy finds further support in the circumstance that, unlike owls, diurnal raptors are not actually named as ***po***. Auditory features are implicated in this taxonomy only insofar as several component terms, including of course ***po*** as the label for 'owl', are onomatopoeic. Yet, in this case at least, onomatopoeia pertains to nomenclature rather than to classification per se. There is a classification of ***po*** sounds, but this is not at all articulated with a classification of birds. By the same token, birds figure in a class of ***po***-sounding entities (as distinct from the class of ***po*** sounds) only to the extent that owls and other avian kinds are considered as partial, physical manifestations of things that are essentially non-physical, invisible, and, indeed, non-ornithological. These are of course kinds of malevolent spirits. Expressing this another way, one can say that spirits compose an auditorily defined whole of which certain birds form a part. Accordingly, while there are contexts where Nage identify physical birds (such as high-flying hawks) with harmful spirits, it is on the whole the ***po*** sounds that they regard as their most immediate manifestation. Thus Nage are able to experience nocturnal sounds directly as manifestations of spirits, rather than as cries of owls and other birds rationalized as visible embodiments of these spirits.

In Nage ethnoornithological classification, this part-whole relation between auditory and visual percepts is of course reversed, as indeed it is in western vernacular and scientific nomenclatures where onomatopoeic designations (see for example, "crow," "cuckoo," and indeed "owl") are similarly applied to natural kinds distinguished on non-auditory grounds. Thus in this domain, the auditorily motivated (or onomatopoeic) name ***po*** figures as the part arbitrarily designating a visible whole, that is, a taxon defined primarily by visual criteria.[16] It is by now well established that "a single term referring to a natural kind, even one whose empirical referents remain partly constant over a variety of contexts, can figure in

more than one classificatory schema" (cf. Forth 1995). ***Po*** provides a particularly clear example of this general possibility. As the only visible entities actually denoted by ***po***, owls form a discrete taxon in a perceptually based folk ornithology while remaining focal to a culturally specific, symbolic complex of "things that go ***po*** in the night".

NOTES

[1]Nage dialects are closely related to those spoken in the Ngadha region, to the west, and in the Ende region, to the east. All languages of central Flores are provisionally classifiable as members of a Bima-Sumba group (Esser 1938), which forms part of Blust's (1980) Central-Malayo-Polynesian branch of the Austronesian languages. In what follows I refer mostly to the dialect spoken in the vicinity of the western Nage village of Bo'a Wae. When I refer to "Indonesian" I mean the Malay-based national language, Bahasa Indonesia.

[2]There is no single Nage word or phrase denoting birds. When necessary, a class of birds can be distinguished with descriptive phrases such as ***ana wa ta'a co zéta lizu*** 'animals that fly high in the sky'. Contextually, Nage also refer to birds in general as ***ana peti***, a term that specifically denotes small passerine birds. This matter is more fully discussed in Forth 1996a:93-95.

[3]Following Verheijen (1963, 1967), in western Flores (Manggarai) ***po*** usually denotes two species of the genus *Otus* (*O. alfredi* and *O. sylvicola*) as well as the Barn Owl (*Tyto alba*). Owing to difficulties of observation, information on owl species in Nage derives mostly from informants' descriptions. Neither preserved specimens, nor detailed illustrations of either nocturnal or diurnal raptors, nor sound recordings of Strigiformes (see Hunn 1992) were available for use in the field.

[4]All three terms correspond to what Berlin, Breedlove, and Raven (1973), in their classification of ethnobiological names, distinguish as primary, analyzable, and unproductive lexemes. In accordance with their synonymy, the terms cannot be considered either productive or secondary lexemes, since none actually names a specific kind of a more inclusive ethnoornithological taxon designated as ***po***. By the same token, in Conklin's (1962) scheme, the three terms are identifiable as unitary and complex, rather than as composite lexemes.

[5]Just one Nage man ever spoke of the three terms as referring to bird 'kinds' (Indonesian *jenis*). It is probably significant, moreover, that of all my informants, he had the most formal education and that, when naming birds in free recall, only he spontaneously classified a variety of birds into several generic categories employing national language terms such as *elang* (hawk) and *burung hantu* (owl).

[6]Things may be different in other parts of central Flores. In the Keo region, to the south of Nage, I recorded ***po pate*** as a reference to a bird of prey that swoops down on domestic fowls and severs (***pate***) their heads with its sharp wing. Although I am unable to provide a secure identification, the description is reminiscent of one or more kinds of falcon (perhaps including the Peregrine, *Falco peregrinus*) that Nage designate as ***bele teka*** 'sharp wing'. At the same time, the characteristic decapitation was said always to be performed in the night. One Nage man suggested that ***po kua*** might refer to eagles (***kua***), but this appeared to be little more than a speculation based on a grammatical possibility. All other evidence indicates that ***po kua*** denotes owls.

[7]Six of ten informants did not mention ***je*** at all in free recall, though all but one of the six recognized it as a bird name when I questioned them later. Three of the other four listed ***je*** right after ***po***. The name ***je*** is not onomatopoeic but refers to the bird's reputed habit of stealing up on sleeping prey. In this respect, it is worth noting, the name resembles those of several of the diurnal raptors (e.g. ***bele teka, jata, sizo, wole wa***), which similarly refer to morphological or behavioral features (Forth 1996a).

[8]Nage ***bhia ko'o*** 'kind of', '(to possess the) form of', expresses both class inclusion and resemblance (Forth 1995). Yet to describe a daytime raptor as ***bhia ko'o po*** could, I was assured, only mean that the bird resembled an owl, either physically or vocally.

[9]In free recall only one informant gave one of the sound terms — ***po bapu*** — as the name of a bird. This, moreover, he speculatively identified with the ***je***, or Hawk-Owl. Given that sounds classified as ***po*** are probably made exclusively by owls, including indeed the Hawk-Owl, it is not impossible that, through observation, individual Nage have come to link particular sound categories with particular species of Strigiformes. This however is contrary to the general pattern, whereby all ***po*** sounds are attributed to all (or nearly all) raptorial birds. It is also contradicted by the doubts of some informants about the ability of the ***je*** to produce any such sound. One particularly knowledgeable informant furthermore claimed that the ***je*** was mute (***mona sezu***).

[10]Being encountered also in western Flores (Manggarai; Verheijen 1950: 67) and in eastern Sumba (Onvlee 1984: 196 s.v. ***bhia ko'o***), the idea that night birds, particularly owls, reveal the presence of wild pigs appears to be widespread in eastern Indonesia. In Nage hunting augury, nocturnal cries of two other birds — the Savannah Nightjar (***leba***, *Caprimulgus affinus*) and the Pied Bush-chat (***tute péla***, *Saxicola caprata*) — are on the contrary regarded as portents of an unsuccessful hunt. Neither bird is associated with witches or malevolent spirits, nor with sounds classified as ***po***.

[11]As a parallelism, ***po uci*** is further elaborated by interposition to become ***po ko, uci meci***. Although apparently more characteristic of other dialects, ***po ko*** was equated by western Nage informants with ***po keo*** (an identification which suggests that this term too might be construed in terms of this parallelism). On the other hand, ***meci***, the paired term of ***uci*** in the more elaborate expression, denotes a nocturnal — and ventriloquistic — sound attributed to a cricket named by the same term. With regard to regional variations, it should also be noted that an informant from northeastern Nage stated that ***po kusi*** (= western Nage ***po uci***) and ***po ko*** could be distinguished as auditory manifestations of the anger of ancestors and of witches respectively. This distinction introduces a contrast not found among ideas regarding ***po*** in western Nage, where the category is not linked with ancestral spirits or the dead. A Keo informant claimed that ***ko*** denoted an owl smaller than owls named ***po*** but possessing larger eyes. The same man, however, later described ***po***, ***ko***, and ***uci*** as references only of different sounds produced by the same birds.

[12]While Feld's analysis of Kaluli knowledge of birds is illuminating in regard to some Nage conceptions of ***po***, on the whole he appears to consider visible birds as manifestations of spiritually derived sound in all epistemological contexts. In contrast, the Nage evidence suggests the existence of a distinct ethnoornithological domain in which spiritual associations and auditory capabilities are mostly irrelevant.

[13]In standard Indonesian, by contrast, both *burung suangi* and the synonymous *burung hantu* ('spirit bird') refer specifically to owls. The association of owls with witches and spirits is

of course extremely widespread. In European traditions, the connection is reflected, for example, by Latin morphemes from which are derived the scientific names Strigidae and Strigiformes (see e.g., *striga*, "an evil spirit supposed to howl in the night" (Glares 1982:1828), "a woman that brings harm to children, a hag, a witch" (Andrews 1907:1766), and *strix*, "a kind of owl, regarded as a bird of ill omen, sometimes as a vampire or evil spirit" (Glares 1982:1829).

[14]Also noteworthy in this connection is the belief that crows visibly manifest harmful spirits called ***noa*** which inflict disease on large livestock and later feed on the carcases of their victims. The flesh of birds that Nage classify as 'witch birds', raptors and scavengers alike, is generally prohibited as food.

[15]This particular observation is reminiscent of the views of Douglas (1966) and Leach (1964), who argue that special ritual significance is attached to animals that are anomalous in relation to a pre-conceived, and largely visually and morphologically defined, categorization of life-forms. For the most part, however, the present analysis accords with Hunn's critique of Douglas's interpretation of the abominations of Leviticus. After demonstrating how 18 or 19 of the 20 birds proscribed as food in Leviticus are meat or fish eaters, Hunn argues that they are forbidden precisely because of their feeding habits, and not because they are somehow anomalous in relation to the category 'bird' (1979:111). Since the majority of these kinds mentioned in Leviticus are Falconiformes and Strigiformes, the group closely corresponds with the complex of birds to which Nage attribute ***po*** sounds, and even more closely to the larger group of Nage 'witch birds'. As remarked in the previous note, raptors and other 'witch birds' are forbidden as food among Nage as well.

[16]In support of possible connections between taxonomy and visually-based literate culture, Ong (1977:139) points out that English "species" derives from Latin *specio*, meaning "to look at, behold." Contrary to Ong, however, the evidence of the present paper suggests that taxonomic ordering of natural kinds may be based primarily on visual criteria in oral cultures as well.

ACKNOWLEDGEMENTS

This essay is based on a paper read at the 17th Annual Conference of the Society of Ethnobiology held in Victoria, British Columbia, 16-19 March 1994. Information on Nage ethnoornithological classification was collected during several visits to Flores beginning in 1984, as part of a general ethnographic study focused on matters of indigenous cosmology, ritual, and social organization. Research in the Nage region was sponsored by the Indonesian Institute of Sciences (LIPI), the National Institute for Cultural Research (LRKN), and Nusa Cendana University. Financial support was provided at various times by the British Academy, the Central Research Fund of the University of Alberta, and the Social Sciences and Humanities Research Council of Canada. I am grateful to all of these bodies for their assistance.

LITERATURE CITED

ANDREWS, E. A. (editor). 1907. Harper's Latin Dictionary. American Book Company, New York and Cincinnati, Ohio.

ARNDT, PAUL. 1961. Wörterbuch der Ngadhasprache. Studia Instituti Anthropos 15. Suisse: Anthropos-Institut, Fribourg, Germany.

ATRAN, SCOTT. 1990. Cognitive Foundations of Natural History. Cambridge University Press, Cambridge.

BERLIN, BRENT. 1992. Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies. Princeton University Press, Princeton, New Jersey.

BERLIN, BRENT, J. BOSTER, and J. O'NEILL. 1981. The perceptual bases of ethnobiological classification: Evidence from Aguaruna folk ornithology. Journal of Ethnobiology 1:95-108.

BERLIN, BRENT, D. E. BREEDLOVE, and P. H. RAVEN. 1973. General principles of classification and nomenclature in folk biology. American Anthropologist 75:214-242.

BERLIN, BRENT and J. O'NEILL. 1981. The pervasiveness of onomatopoeia in Aguaruna and Huambisa bird names. Journal of Ethnobiology 1: 238-261.

BLUST, ROBERT. 1980. Early Austronesian social organization: The evidence of language. Current Anthropology 21 (2):205-247.

BULMER, RALPH. 1974. Folk biology in the New Guinea Highlands. Social Science Information 8:9-28.

———. 1979. Mystical and mundane in Kalam classification of birds. Pp. 57-79 *in* Classifications in Their Social Context. Roy F. Ellen and David Reason (editors). Academic Press, London.

COATES, BRIAN J. and K. DAVID BISHOP. 1997. A Guide to the Birds of Wallacea: Sulawesi, the Moluccas and Lesser Sunda Islands, Indonesia. Dove Publications, Alderley, Australia.

CONKLIN, HAROLD C. 1962. The lexicographical treatment of folk taxonomies. International Journal of American Linguistics 28(2):119-141.

DOUGLAS, MARY. 1966. Purity and Danger: An Analysis of Concepts of Pollution and Taboo. Routledge & Kegan Paul, London.

ELLEN, ROY. 1993. The Cultural Relations of Classification: An Analysis of Nuaulu Animal Categories from Central Seram. Cambridge University Press, Cambridge.

ESSER, S. J. 1938. Talen. Blad 9b *in* Atlas van Tropisch Nederland. Martinus Nijhoff, 's-Gravenhage, The Netherlands.

FELD, STEPHEN. 1982. Sound and Sentiment: Birds, Weeping, Poetics, and Song in Kaluli Expression. University of Pennsylvania Press, Philadelphia.

FORTH, GREGORY. 1989. The *pa sése* festival of the Nage of Bo'a Wae (central Flores). Pp. 502-519 *in* Rituals and Sociocosmic Order in Eastern Indonesian Societies. Cécile Barraud and Jos Platenkamp (editors). Special issue of Bijdragen tot de Taal-, Land-en Volkenkunde 145.

———. 1993a. Social and symbolic aspects of the witch among the Nage of eastern Indonesia. Pp. 99-122 *in* Understanding Witchcraft and Sorcery in Southeast Asia. C. W. Watson and Roy Ellen (editors). University of Hawaii Press, Honolulu, Hawai'i.

———. 1993b. Ritual and ideology in Nage mortuary culture. Southeast Asian Journal of Social Science 21(2):37-61.

———. 1995. Ethnozoological classification and classificatory language among the Nage of eastern Indonesia. Journal of Ethnobiology 15(1):45-69.

———. 1996a. Nage birds: Issues in the analysis of ethnoornithological classification. Anthropos 91:89-109.

———. 1996b. To chat in pairs: Lexical pairing as a pervasive feature of Nage mundane speech. Canberra Anthropology 19(1):31-51.

———. 1998. Beneath the Volcano: Religion, Cosmology and Spirit Classification among the Nage of Eastern Indonesia. (Verhandelingen No. 177) Royal Institute of Linguistics and Anthropology, Leiden.

GEDDES, W. R. 1945. Deuba: A Study of a Fijian Village. (Memoirs of the Polynesian Society, Vol. 22.) The Polynesian Society, Wellington, New Zealand.

GLARES, P.G.N. (editor). 1982. Oxford Latin Dictionary, Combined Edition. Clarendon Press, Oxford.

HUNN, EUGENE S. 1976. Toward a perceptual model of folk biological classification. American Ethnologist 3:508-524.

———. 1977. Tzeltal Folk Zoology: The Classification of Discontinuities in Nature. Academic Press, New York.

———. 1979. The abominations of Leviticus revisited: A commentary on anomaly in symbolic anthropology. Pp. 103-116 *in* Classifications in Their Social Context. Roy F. Ellen and David Reason (editors). Academic Press, London.

———. 1982. The utilitarian factor in folk biological classification. American Anthropologist 84:830-847.

———. 1992. The use of sound recordings as voucher specimens and stimulus materials in ethnozoological research. Journal of Ethnobiology 12(2):187-198.

JESPERSEN, OTTO. 1921. Language: Its Nature, Development, and Origin. Allen and Unwin, London.

LAKOFF, GEORGE. 1987. Women, Fire and Dangerous Things: What Categories Reveal About the Mind. University of Chicago Press, Chicago.

LEACH, EDMUND. 1964. Anthropological aspects of language: Animal categories and verbal abuse. Pp. 23-63 *in* New Directions in the Study of Language. Eric H. Lenneberg (editor). MIT Press, Cambridge, Massachusetts.

MACKINNON, JOHN. 1991. Field Guide to the Birds of Java and Bali. Gadjah Mada University Press, Yogyakarta, Indonesia.

ONG, WALTER J. 1977. Interfaces of the Word: Studies in the Evolution of Consciousness and Culture. Cornell University Press, Ithaca, New York, and London.

———. 1982. Orality and Literacy: The Technologizing of the Word. Methuen, London and New York.

ONVLEE, L. 1984. Kamberaas (Oost-Soembaas)-Nederlands Woordenboek. Foris Publications, Dordrecht, The Netherlands.

RANDALL, ROBERT and EUGENE S. HUNN. 1984. Do life forms evolve or do uses for life? American Ethnologist 11:329-349.

RIPS, LANCE J. 1975. Inductive judgements about natural categories. Journal of Verbal Learning and Verbal Behavior 14:665-681.

TUZIN, DONALD. 1984. Miraculous voices: The auditory experience of numinous objects. Current Anthropology 25(5):579-596.

VERHEIJEN, JILIS A. J. 1950. De stem der dieren in de Manggaraise folklore. Bijdragen tot de Taal-, Land- en Volkenkunde 106:55-78.

———. 1963. Bird names in Manggarai, Flores, Indonesia. Anthropos 58:677-718.

———. 1967. Kamus Manggarai. I: Manggarai-Indonesia. Martinus Nijhoff, 's-Gravenhage, The Netherlands.

Ethnobotany of the Primitive Tribes in Rajasthan. Prabhakar Joshi. Printwell, Jaipur, India. 1995. Pp. 313. US$50 (cloth).

Rajasthan is the second-largest state of India, half the size of Texas. It consists mostly of the arid regions in eastern India, along the Pakistani border. Over 5,000,000 of its 29,000,000 inhabitants are considered tribal peoples, living mostly in the rugged hills in the southern part of the state. These people are divided into six major and six minor tribes. Archaeological evidence suggests they may be descended from people who have lived in the region for millenia.

This remarkable book represents an extremely broad-based ethnobotany of the 12 tribes of the area. In addition to common ethnobotanical subjects such as food, medicine, and narcotics, the author addresses unusual topics in great detail, down to which species are used for hats, syringes, umbrellas, and pulleys. Children's toys are discussed, as are ceremonial decorations, musical instruments, tatoos, games, and practical jokes. One game involves a tug of war in which the two contestants are each given the stamen from a particular flower and asked to use it to pull the anther off the opponent's stamen. There are 19 pages devoted to the lyrics of plant-centered folksongs and 12 pages containing plant-related proverbs such as "A *matira* (*Citrullus lanatus*) cannot be placed in the mouth of a goat," i.e., "one cannot go beyond one's means."

If the book has a flaw, it is that the author rarely distinguishes between the various tribes. Information from all 12 is lumped together indiscriminately, even with respect to common names. Certainly there must be some variation among such a large and diverse group of people. Nevertheless, it is a first-class example of empirical ethnobotany, as enjoyable as it is useful.

Joseph E. Laferrière
Herbarium, 113 Shantz Bldg.
University of Arizona
Tucson AZ 85721 USA

Journal of Ethnobiology 18(2):211-227 Winter 1998

INTERPRETING WILD SEEDS FROM ARCHAEOLOGICAL SITES: A DUNG CHARRING EXPERIMENT FROM THE ANDES

CHRISTINE A. HASTORF
Department of Anthropology
University of California, Berkeley
California 94720-3710

AND

MELANIE F. WRIGHT
The Data Archive
University of Essex
Colchester CO4 3SQ
ENGLAND

ABSTRACT. — Many parts of the Andean highlands are grasslands. In these areas, the inhabitants need to use dung regularly for fuel. This fuel use is also a likely scenario for the pre-Hispanic past. Because of this, we must be careful about interpreting plant taxa that possibly could have entered the archaeological record via burned dung. To better understand the sources of small seeds in xerophytic Andean sites, we charred samples of modern dung from three regions in the Andes to assess their charred seed contents. We find that seed contents in charred dung differ by region and by animal. Our data suggest that certain co-occurring seed taxa in camelid dung may be considered a likely dung signatures of these animals.

RESUMEN. — Muchas partes de la zona alta andina son pastizales. En estas áreas, los habitantes necesitan usar regularmente estiércol como combustible. Este uso como combustible es también un escenario probable para el pasado prehispánico. Por ello, debemos tener cuidado acerca de la interpretación de taxa vegetales que posiblemente puderian haber entrado en el registro arqueológico por vía del estiércol quemado. Preocupadas acerca del origen de semillas pequeñas en sitios arqueológicos andinos en ambientes secos, llevamos a cabo un experimento quemando estiércol animal moderno para estudiar su contenido después de carbonizarlo. Hemos quemado una serie de estiércoles animales modernos de tres regiones de los Andes. Presentamos los resultados de estos experimentos quemando estiércol moderno de los Andes para evaluar su contenido de semillas carbonizadas. De las tres regiones de los Andes encontramos que los taxa vegetales difieren por región y por animal. La co-presencia de ciertos taxa es suficientemente común para los camélidos como para ser considerados probables "firmas" de estiércol, a tomarse en cuenta al hacer interpretaciones de datos.

RÉSUMÉ.— Plusieurs parties des Hautes-Terres des Andes sont constituées de prés. Dans ces zones, les habitants doivent utiliser les excréments comme combustible. Un tel usage des excréments a pu être répandu durant la période préhispanique. Ainsi, nous devons être prudents lorsque nous interprétons des taxons de plantes qui ont pu se glisser dans les données archéologiques par le biais d'excréments brûlés. Préoccupés par l'origine de petites graines provenant de sites environnementaux secs des Andes, nous avons procédé à une

expérimentation en carbonisant des excréments d'animaux modernes pour connaître leur contenu après la carbonisation. Nous avons carbonisé une série d'excréments d'animaux contemporains provenant de trois régions andines. Nous présentons les résultats de ces expérimentations visant à évaluer le contenu carbonisé des graines provenant d'excréments d'animaux modernes des Andes. Nous avons découvert que les taxons de plantes diffèrent selon chacune des trois régions andines par région et par animal. Certains taxons cooccurrents se présentent assez fréquemment dans le cas des camélidés pour être traités comme des "signatures" d'excréments pouvant être prises en considération dans l'interprétation des données.

The goal of this study was to assess burnt animal dung as a source of seeds in archaeological soil flotation samples from the Andes of South America. Dung is a common constituent of flotation samples from the Andean highlands (Browman 1986:140; Hastorf 1993; Lennstrom 1991; Johannessen and Hastorf 1990; Pearsall 1983, 1988, 1989; Wright, Hastorf, and Lennstrom, in press). Dung is also a preferred fuel source for many uses today in the high, dry grassland regions of the Andes mountains (Winterhalder, Larson, and Thomas 1974). Archaeologists have found dung fragments in excavated soil flotation samples for some time and are aware of its importance as a fuel source (Browman 1986; Pearsall 1988). The extent of dung use and it's impact on the interpretation of plant assemblages from archaeological sites continues to be an issue in paleoethnobotanical interpretation. Thus, we set out to assess what seeds occur in dung, what happens taphonomically to those seeds when they are burned, and how the seeds in dung reflect the local Andean environment. We hope our data may contribute to better modeling of this aspect of past human behavior and plant use.

ETHNOGRAPHY OF DUNG USE

Today, dung from many domesticated animals, e.g., cow, sheep, goat, guinea pig, llama, and alpaca, is used as fuel, but it is particularly camelid dung that we find in the archaeological samples. We believe that domestic camelids, the llama (*Lama glama* L.) and alpaca (*L. pacos* L.) were the most important dung sources in most archaeological settings. Llamas are the more common species today, but alpacas may also provide dung. Llamas and alpacas mark their territory by defecating in mounds. Thus, their dung is easily collected from both corraled or free ranging animals. Camelid dung is large and sufficiently distinctive that fragments in floated soil samples are identifiable.

In the Andes, the traditional cooking fire is most often a small hearth, with baked earth sides, placed against a wall. Where hearths are protected from wind, they are typically above-ground and thus oxidizing in nature. Most are fueled heavily twice a day, then left to smoulder for hours. Most habitation compounds have a pile of fuel in the cooking area. Some families maintain a dung pile in their nearby corrals that is periodically treated to make it better fuel (Sikkink 1988). Dung, twigs, maize cobs, straw, and wood are used in these fires (Johannessen and Hastorf 1990:67). Next to wood, dung is the preferred traditional cooking fuel in the Jauja region of Peru (Johannessen and Hastorf 1990:68). *Watias* or field ovens in modern Bolivia and Peru use large quantities of camelid dung as fuel for

roasting meat, potatoes, vegetables, and cheese. These slow and steadily burning fires remain hot for hours. As ovens may be dug slightly into the earth, they can produce more of a reducing atmosphere. Chávez (1986) and Sillar (1994) attest to the preference for camelid dung as fuel in the open-air firing of pottery, built and burned above ground.

ARCHAEOLOGICAL PATTERNS

In our work with archaeological materials from the Middle Horizon site of Tiwanaku[1] in Bolivia (ca. AD 400-1000), camelid dung remains show a distinctive depositional pattern among the excavation areas (Wright, Hastorf, and Lennstrom, in press). It would appear that in many areas, dung is being treated differently from other refuse. Not all areas within Tiwanaku display the same intensity of dung use. For example, dung is more likely than other archaeobotanical remains to occur discretely in pits rather than being distributed across floor and living surfaces. We have suggested that these patterns of dung distribution at Tiwanaku may reflect not only the inhabitants' use of dung as fuel, but also their conceptions of purity and spatial boundedness, including social and possibly ethnic or moiety differences at that capital city.

In addition to pieces of dung recovered from the flotation samples, we have also found many seeds that might have entered the record by way of dung burning. Clearly, dung was at settlements and was probably used as a fuel. What we hope to clarify here is the range of plant taxa represented by and the conditions of the seeds that might have entered the site through the use of dung as fuel. These results will inform interpretations of the archaeobotanical evidence in different Andean cultural contexts.

Seeds in Andean dung. — The vast majority of seeds recovered from samples excavated at Tiwanaku[1] are of small weedy taxa that could be from animal dung. We decided that a controlled study of the seeds in modern burned dung samples of known provenience would contribute to our understanding of the Andean archaeobotanical samples, not only from the Tiwanaku excavations, but from dry-environment archaeological sites in general. We need to better understand the sources of seeds that we find in our soil flotation samples in order to better interpret the activities they represent.

Miller (1984, 1997), Miller and Smart (1984), and Miller and Gleason (1994) have shown for Old World sites that small seeds may come from dung burned at the site. Burned dung is particularly likely to be the source of small weedy seeds of dry environments such as steppes and high mountain regions where other sorts of fuel are scarce. However, we cannot simply assume that all small seeds recovered from flotation on sites in dry environments are from dung (Hillman, Legge, and Rowley-Conway 1997). There are many paths by which seeds enter the archaeological record (Pearsall 1988).

Hastorf's Archaeobotany Laboratory — now housed at the University of California at Berkeley — over the years has received samples of modern dung from highland regions of Peru, Argentina, and Bolivia, locations where we have participated in archaeological excavations. The plant communities available to grazing

animals in these areas are known, so we may determine the plant taxa actually included in the dung, and more importantly, identify the taxa which survive burning.

Such a study of plant use and seed transformation also provides a means to investigate ecological zone use archaeologically, since it is known that contemporary and prehistoric Andean plant assemblages vary quite dramatically by altitudinal zone (Pulgar Vidal 1946; Weberbauer 1945). If dung samples from different areas and various animal species produce readable "signatures" of weedy plant assemblages that reflect local plant communities, this study will provide a more concrete understanding of seed densities and taxa attributable to archaeologically burnt dung, as opposed to direct human use of the small seed taxa.

METHODS

Pre-tests. — First we designed a burning strategy to mimic the most likely types of fires lit in the past as well as the way small seeds were released from dung by burning. An initial pre-test of five camelid dung burnings was undertaken, varying the atmosphere, temperature, and length of heat treatment. In addition, one control dung sample was analyzed unburned. The oxidized samples were burned in an open environment using wood matches as tinder, as wood is easily distinguished from dung matrix and seeds under the microscope post-firing. The reducing samples were embedded in sand within a metal container and heated over a Bunsen burner until charred. Burning time was five-six minutes for the oxidizing samples and 210-240 minutes for the reducing samples. Samples were burned until they were charred throughout. The temperature of the reducing samples ranged from 200° to 600° C. The temperature of the quick-burning oxidizing samples was neither controllable nor accurately measurable. These initial burnings were completed in an attempt to determine which conditions best reproduced past dung use, especially to assess the preservation in flotation sample dung.

Total seed counts were 21.0 seeds/10 gm sample for the reducing atmosphere (n = 2), 20.3/10 gms for the oxidizing atmosphere (n = 3), and 29/10 gms in the unburned sample (n = 1). These figures indicate that 1/3-1/4 of the seeds are destroyed during the burning process. However, the burning did not seem to selectively destroy any particular taxon. The differences in seed counts between oxidizing and reducing conditions was not significant either. In addition, the relative proportions of the different plant taxa present after the burnings do not appear radically different, as can be seen in Figure 1. This is logical, given that the seed taxa represented are all small, compact, and dense.

Since the differences between oxidizing and reducing atmospheres were minimal, we elected to burn the rest of the samples in an oxidizing atmosphere, as this required much less burn time. It may also better represent what actually happened to most dung in past hearths when it was burned for fuel. Though some dung would have been covered by ash sufficiently to have been burned in a reducing atmosphere, most was burned with an open flame in an open hearth.

The burned samples. — From our Archaeobotany Laboratory collections, we selected 25 additional samples of dung, mostly camelid, but also guinea pig (*Cavia* cf. *porcellus*, known locally as *cuy*) and goat (*Capra* spp.) from three sampled regions:

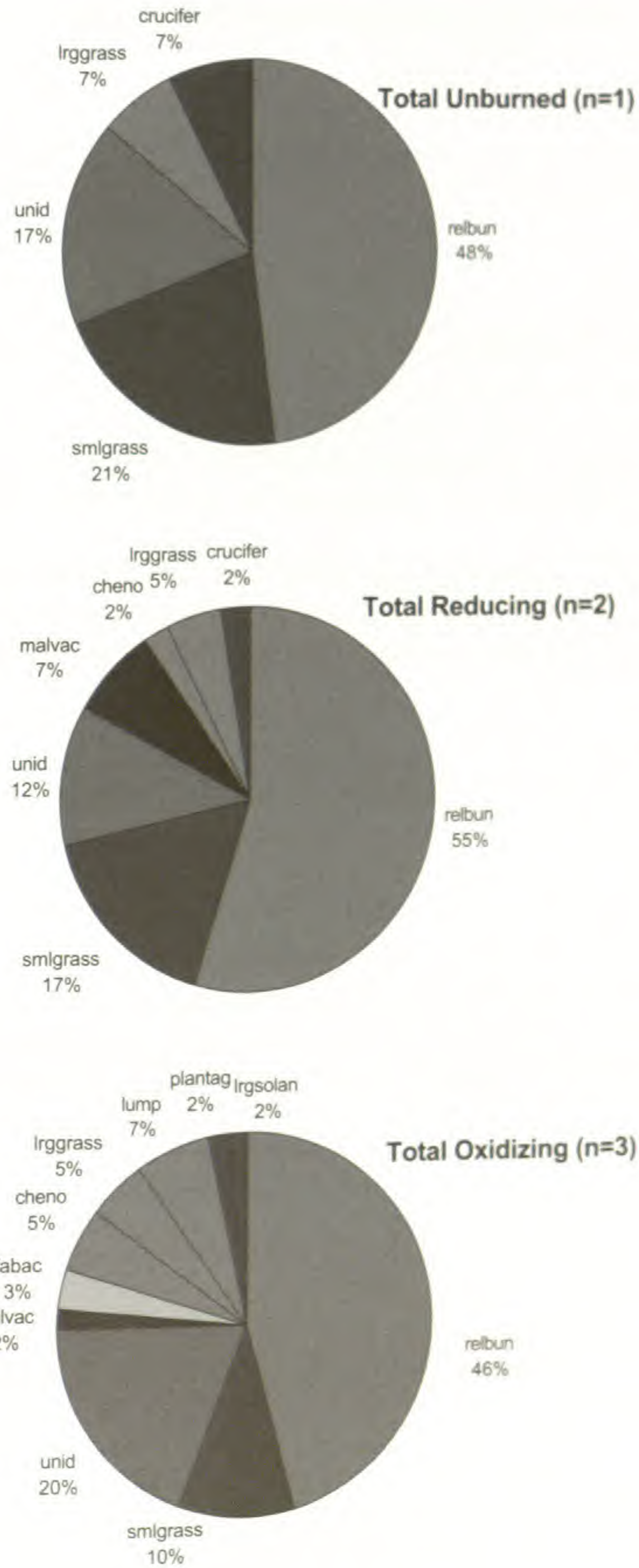


FIGURE 1.— Pre-tests only: Pie charts showing relative composition of seeds from Bolivian camelid dung samples, untreated and treated by reducing and oxidizing atmospheric burning conditions. For pie slice headings, see Appedix 1B.

TABLE 1. — Source and location of the dung samples.

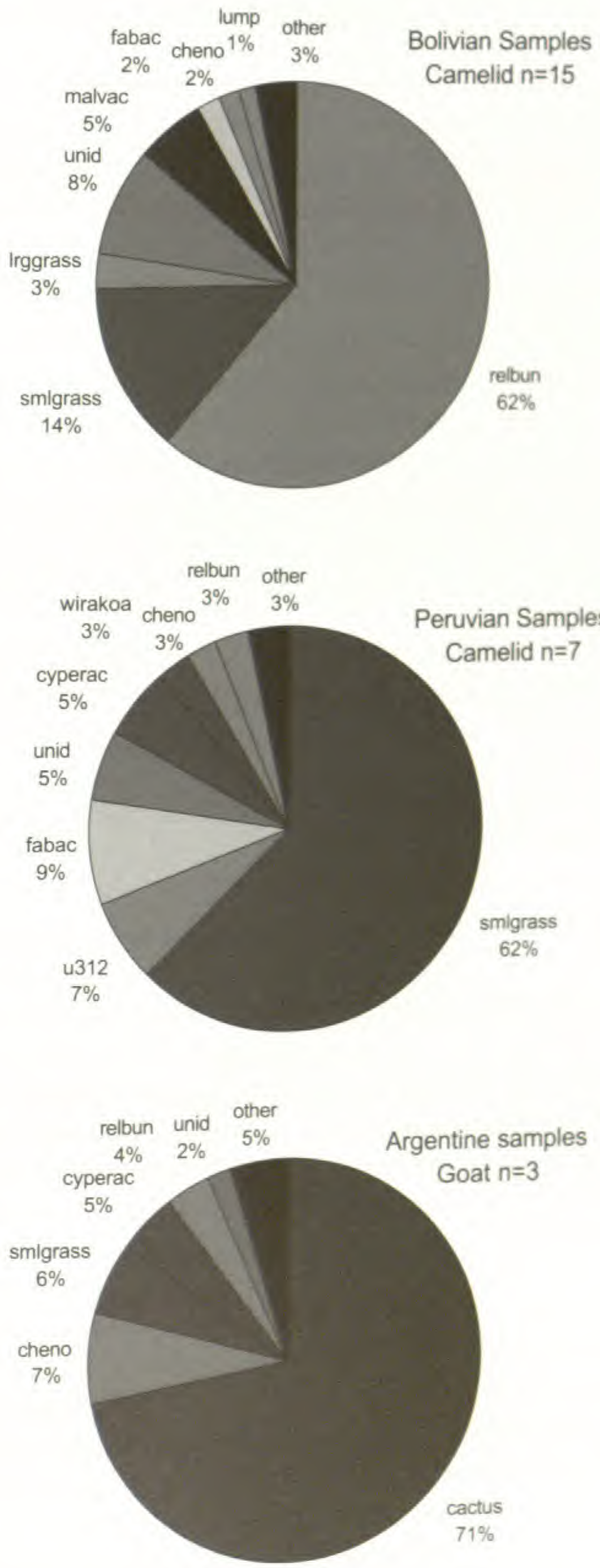
	Guinea Pig	Goat	Camelid	Total
Argentina	0	3	0	3
Peru	5	0	7	12
Bolivia	0	0	16	16
Total	5	3	23	31

Jauja in Peru, Tiwanaku in Bolivia, and Cachi in Argentina. As our dung was limited, we chose ten grams of dung for each sample. For comparison, we analyzed a further sample of unburned guinea pig dung. Along with the six test samples mentioned above, we analyzed a total of 31 ten-gram samples. The number of samples varied by animal species and by source region. These data are listed in Table 1.

Our main focus was on camelid dung from Bolivia in order to be most comparable with the local Tiwanaku samples. However, we added other animals and regions to gain as much information as possible about dung in the Andes. Half (16) of our 31 samples are from Bolivia; 23 of the 31 are from camelids. We burned and analyzed three samples of goat dung collected from the valleys near Cachi in north-west Argentina. Twelve samples of dung came from the Mantaro Valley in Peru; seven of camelid dung were collected in the nearby high puna; five samples of guinea pig dung were collected from a household on the Mantaro Valley floor; and 16 samples of camelid dung derived from the fenced enclosure surrounding the site of Tiwanaku in the altiplano of Bolivia, near Lake Titicaca, all high intermontane valley locations.

The experiment. — Each of the samples to be burned was weighed prior to and after burning. We also recorded the burn time once completed. As in the pre-test, the dung was burned on top of the ignited wood tinder for about five minutes. When there were no more open flames (although sometimes still burning embers), the burned residue was sifted through a series of geological sieves, gently shaking and prodding with probes to aid the separation. Sieves of 2 mm, 1.18 mm, and 0.5 mm were used to separate the burnt dung and extract the seeds. The seeds from this oxidizing treatment seemed to retain their shape and had minor charring contortions, which was helpful in our study. Each of these fractions was sorted under a microscope at 5x-25x. The seeds and seed fragments were then removed and identified, sometimes to genus, but usually only to family. The wood tinder remains were removed.

The counts of whole seeds and seed fragments greater than half of the seed were recorded by taxon. Figure 2 displays pie charts showing the relative proportions of the different taxa by region and animal. We undertook further statistical analyses in an attempt to identify plant taxa or combinations of taxa which might act as "signatures" for certain animals or certain environments (using SAS for Windows ver. 6.03 on a PC).



N.B. The Guinea Pig samples (n = 5, from Peru), including one unburned sample (see sample 23 in Appendix 1), contained no identifiable seeds.

FIGURE 2. — Pie charts showing relative composition of seeds from burned dung samples by region and animal; for comparison, the one unburned camelid sample is shown in Figure 1.

RESULTS

We present the results of our burning experiment in two major categories; by the animal producing the dung and by the region where the dung was collected. The complete data set is listed in Appendix 1. Both the region and the animal taxon affected the results. It is unfortunate that due to the limited samples available, we were not able to separate these two variables completely. Nevertheless, we can still draw some useful conclusions about seeds entering the archaeological record via burnt dung.

By animal. — In this larger sample, animal type (and region) did have a significant effect on what seeds are contained in the dung, unlike the pre-test when there were no major differences. We were unable to examine these differences systematically across all three animal taxa and all three zones, since all the goat dung was from Argentina and we had no camelid dung from there. Therefore it is difficult to say whether the differences observed are due to animal behavior, to location, or both (Figure 2).

One difference is clearly related to the animal species. Guinea pig dung, both charred and uncharred, contained no recognizable plant macroremains from either Bolivia or Peru. (We had no guinea pig dung from Argentina.) Apparently guinea pig digestion rarely allows for whole seed survival.

Some differences emerge from an analysis of the contents of the goat dung from Argentina and the camelid dung from Bolivia and Peru. The three goat dung samples average 5.33 plant taxa per sample (16-59 seeds/sample). The 23 camelid samples average 4.60 plant taxa/sample (4-46 total seeds/sample). Thus, goat dung was more productive of seeds than camelid dung, and the goats grazed less discriminately, as a greater range of plant taxa appeared in their dung than in that of the camelids.

If the range of plants represented in the dung seed assemblages are compared with the current local plant communities in the three regions, the difference between the two animals is noteworthy. The environment around Cachi, Argentina is a relatively sparse, high, dry desert (Heyne 1992) with perhaps fewer species available for grazers when compared to the altiplano grasslands of the Tiwanaku Valley (Weberbauer 1945; Pulgar Vidal 1946) or the Peruvian puna, which is like the altiplano, high and cool, but slightly wetter (Weberbauer 1945; Tosi 1960). Though there were fewer plant taxa available, the goats utilized a broader range of plant taxa. We may infer that goats are less discriminating grazers than camelids, or that the goats ranged across more microenvironmental zones.

The eight most commonly occurring plant taxa from all large animal dung samples taken together (in decreasing order of frequency) are 1) *Relbunium* (Rubiaceae), 2) small grasses, 3) *Chenopodium* (Chenopodiaceae), 4) Malvaceae, 5) Fabaceae (wild legumes), 6) large grasses (mainly *Stipa ichu*), 7) Cyperaceae (sedges), and 8) Cactaceae. These eight taxa were placed in a simple discriminate analysis (SAS procedure DISCRIM) to test the ability of the plant assemblages to associate with and therefore identify the animals producing the dung (Table 2). Based on this analysis, 100% of guinea pig dung samples were correctly classified, 67% of goat samples (with 33% misidentified as camelid), and 96% of camelid dung (both Bolivian and Peruvian samples). One seedless camelid sample was misclassified as guinea pig.

TABLE 2. — Discriminant analysis by animal taxa.

ANIMAL	Guinea Pig	Goat	Camelid	Total
Guinea Pig	5 **100.00**	0 0.00	0 0.00	5 100.00
Goat	0 0.00	2 **66.67**	1 33.33	3 100.00
Camelid	1 4.35	0 0.00	22 **95.65**	23 100.00
Total	6 19.35	2 6.45	23 74.19	31 100.00
Priors	0.1613	0.0968	0.7419	

These clusters suggest that the seed taxa should allow us to identify correctly the animal that produced the dung in these different environments. These results also have interesting implications for analyzing Colonial assemblages, where sheep, goat, or cattle dung may have been used as fuel in addition to camelid dung. If these dung occurred on a site, we might be able to model their entrance into the deposits and therefore the extent of their use. Archaeologically, however, the only two fuel dung sources were camelid and guinea pig, and our results make clear that any identifiable macrobotanical remains from dung would be from camelids. For the altiplano therefore, we are only concerned with the seeds that entered the pre-contact archaeological record via camelid dung use.

By region. — The differences in the plant taxa found in the dung are most striking when regions are compared. The three sources of dung — Bolivia, Peru, and Argentina — occur in quite distinct proportions (Figure 2). The Argentine goat samples (n = 3) are overwhelmingly Cactaceae, with some *Chenopodium* and grasses. The Peruvian camelid assemblages (n = 7) are dominated by grasses, with significant amounts of wild legumes and sedges, and some *Chenopodium*. (The five guinea pig samples from Peru contained no identifiable seeds.) The fifteen Bolivian camelid samples, are dominated by *Relbunium*, with grass as the next most common plant category, along with some Malvaceae, *Chenopodium*, and Fabaceae (wild legumes).

We conducted discriminate analysis using the same technique as above but with the dung samples grouped by region rather than by animal. We again used the eight most common plant taxa, in order to see how accurately one could identify the region from which the dung came from the plant assemblages present in the dung (Table 3). The region was correctly classified in 67% of the Argentine samples, 88% of the Peruvian camelid samples, and 94% of the Bolivian samples.

In an attempt to refine the discriminating power still more, the four most common taxa from each location were combined to create new discriminating variables: FACTARG, FACTPERU, and FACTBOL. FACTARG includes Cactaceae + *Chenopodium* + small Poaceae + Cyperaceae, FACTPERU has small Poaceae + Fabaceae (wild legume) + Unknown 312 + Cyperaceae, and FACTBOL includes *Relbunium* + small Poaceae + Malvaceae + large Poaceae. Using only these three variables, correct classification increased to 100% for Argentina, 88% for Peru, and 94% for Bolivia (Table 4). Thus it would appear that we have fairly good regional "signature" plants within the dung seeds we analyzed.

TABLE 3. — Discriminant analysis by region.

SITE	Argentina (goat)	Peru (camelid)	Peru (guinea pig)	Bolivia (camelid)	Total
Argentina (goat)	2 **66.67**	0 0.00	1 33.33	0 0.00	3 100.00
Peru (camelid)	0 0.00	7 **87.50**	1 12.50	0 0.00	8 100.00
Peru (guinea pig)	0 0.00	0 0.00	4 **100.00**	0 0.00	4 100.00
Bolivia (camelid)	0 0.00	0 0.00	1 6.25	15 **93.75**	16 100.00
Total	2 6.45	7 22.58	7 22.58	15 48.39	31 100.00
Priors	0.0968	0.2581	0.1290	0.5161	

TABLE 4. — Discriminant analysis by region, using regional factor variables, defined by the four most common taxa within the dung.

SITE	Argentina (goat)	Peru (camelid)	Peru (guinea pig)	Bolivia (camelid)	Total
Argentina (goat)	3 **100.00**	0 0.00	0 0.00	0 0.00	3 100.00
Peru (camelid)	0 0.00	7 **87.50**	1 12.50	0 0.00	8 100.00
Peru (guinea pig)	0 0.00	0 0.00	4 **100.00**	0 0.00	4 100.00
Bolivia (camelid)	0 0.00	1 6.25	0 0.00	15 **93.75**	16 100.00
Total	3 9.68	8 25.81	5 16.13	15 48.39	31 100.00
Priors	0.0968	0.2581	0.1290	0.5161	

It is a worthwhile exercise to compare the plant assemblages in dung from the different regions with contemporary regional plant communities. The Peruvian and Argentine dung assemblages correlate fairly well with the known modern plant communities. The dry landscape around Cachi, Argentina, is dominated by cacti and leguminous trees, as is the archaeological wood assemblage (Heyne 1992). The Peruvian camelid samples were collected in the high moist puna, an area dominated by grasses (Weberbauer 1945; Pulgar Vidal 1946). The presence of sedge suggests that camelids do occasionally feed in areas near streams and springs within their grazing ranges, a preferred habitat for sedges. In fact, camelids do like moist areas.

The Bolivian plant community is somewhat anomalous when compared to the plant taxa represented in our sample dung from that region. We would not have predicted the high percentage of *Relbunium* found in the dung given the living plant community in that part of the Tiwanaku Valley. The camelids from which the dung was collected graze primarily in the enclosed precinct of the archaeo-

logical site of Tiwanaku. The seven most common plant taxa, after *Relbunium*, in the 16 Bolivian camelid dung samples that we studied, are (in order of abundance): small Poaceae, Malvaceae, large Poaceae, Fabaceae (wild legume), *Chenopodium*, Cruciferae, and Plantaginaceae. However, a botanical reconnaissance of the area did not reveal significant concentrations of *Relbunium*. Instead, this zone is dominated by *ichu* grass (*Stipa* sp.), *t'ola (Baccharis microphill*, Asteraceae), and *khoa* (*Mentha puleguir* and *Satureja boliviana*, Lamiaceae), with a lesser number of leguminous creepers (*Astragalus)*, Asteraceae, and other grasses (Hastorf, Lennstrom, and Wright, field notes). This contrast suggests that the camelids are feeding preferentially on *Relbunium*. If this is so, *Relbunium* present in carbonized archaeological assemblages from the altiplano, or at least in the Tiwanaku Valley sites, may serve as a "signature" of burnt camelid dung. However, some *Relbunium* spp. were used in the pre-Inka Andes as source of a red dye, so there could be other explanations for the presence of this taxon in a site.

Pearsall (1988:103) identified seeds from three modern camelid dung samples from the Junín puna, a high, wet plain like the puna from which we collected the Peruvian camelid dung. She found the following taxa in those samples: Cyperaceae, Caryophyllaceae, *Opuntia floccosa* (Cactaceae), *Sisyrinchium* (Iridaceae), *Relbunium*, *Calandrinia* (Portulacaceae), *Lupinus* (Fabaceae), and Poaceae of various sizes. Several of these taxa also occur in our modern Bolivian and Peruvian camelid dung samples, listed above. Flannery had Pickersgill look at the llama food preferences in Ayacucho as part of his herding study (Flannery, Marcus, and Reynolds 1989:49). There, the camelids preferred grasses, Malvaceae, cf. *Lycopodium* (Lycopodiaceae), a wild legume (*Astragalus)*, lichens, and several Asteraceae. This was a broad diet. Range management studies at the field station, La Raya, Peru, have tracked alpaca food preferences as they ranged freely (Bryant and Farfan 1984). These alter with the season of the year, but in general alpacas too consume a broad diet. While we have learned that large camelids can eat many things, if left alone to forage, they prefer grasses, Cyperaceae, with some *Plantago* (Plantaginaceae), and wild legumes (Bryant and Farfan 1984:333). Of course, the camelids could have been fed by their caretakers, which might affect the plant remain frequencies. The similarities among these analyses suggest that *Relbunium*, wild grasses, and wild legumes are common and preferred camelid foods in high elevation grasslands. Our data and Pearsall's indicate a special place for *Relbunium* in the camelid diet. *Relbunium* occurred in two of Pearsall's three samples, in three of our seven Peruvian puna samples, and in all 16 of our samples from Bolivia.

IMPLICATIONS FOR ARCHAEOLOGICAL INTERPRETATION

The dung samples from the various regions are not strictly comparable. To facilitate conclusions about dung as a source of archaeological seeds, it is advisable to collect data from a specific study region and its associated environmental zones. It would be worthwhile to examine the distribution of the "signature" taxa such as *Relbunium* and the wild grasses, such as *Calamagrostis* and *Poa*, in conjunction with dung fragments at sites such as Tiwanaku or Chiripa. For starters, one may note patterns in the distribution of these taxa in identifiable dung fragments found in soil flotation samples. If the frequencies of seeds normally occurring in

dung are different than in the dung fragments, we may better understand the effects of dung fragmentation. One could also construct a "weighting" or "marking" variable for the regularly occurring dung seed taxa and apply it to interpret contexts where that combination of seed taxa occurs. Some excavation locations would have both dung fragments and these dung seed taxa, but some may have only the seeds. In either case, we could use such "marking" to characterize more sensitively the distribution of dung at sites, and to gain hints about the processes by which the fragments have broken down. In this way we may be better able to infer the presence of camelid dung as well as gain information about the levels of trampling and destruction that may have occurred in different locations on a site.

CONCLUSIONS

This modest experimental study demonstrates that camelid dung burned as fuel is a likely source of seeds in Bolivian archaeological flotation samples. Dung seed content appears not to differ significantly in different burning atmospheres. Thus, a wide variety of burning conditions could have left dung seeds at sites, although there will be some taphonomic seed loss from burning. Seed taxa in dung differ depending on the animal species from which the dung is derived, the season of the year, and the region. In particular, guinea pigs tend not to eat seeds, while goats and Andean camelids do. The selectivity of the grazer may play a role in the diversity of seeds present in the burnt dung, and certain plant taxa may be preferred by certain animals. This grazing selectivity may allow us to recognize "signatures" of dung present at specific sites.

By far the most significant differences in seed taxa seem to be due to geographical (environmental) location. The seed-from-dung assemblages for the three areas are statistically different. Although the plant taxa present are largely the same (with some notable exceptions), their proportions vary significantly. An analysis of the relative proportions of assemblages of "likely dung seeds" can also yield information about what parts of the landscape are being most strongly utilized by camelids. For example, *Relbunium* and grasses found in modern Tiwanaku camelid dung reflect a pampa grassland diet. They do not suggest that these animals had access to wetlands, as did their Peruvian congeners.

However, there are some notable problems to this approach. First, the source of "likely dung seeds" cannot be unequivocally assigned to the burning of dung. Grasses, sedges, and other small weedy taxa may have been used as construction materials, in wool dyeing, or directly as fuel, or they may have been by-products of other activities such as pottery manufacture, winnowing, or sieving of crops, as well as entering the archaeological assemblage through natural processes (Pearsall 1988). The results of our experiments show that dung regularly contains seeds and that if dung was being used regularly as a fuel (as is attested by the presence of burnt fragments of dung), many of the "likely dung seed" taxa probably came from dung.

A second problem is that seeds present in dung do not necessarily reflect the plant taxa present in the landscape in which the animals were feeding; as the animals may feed preferentially from the universe of plants available. The Bolivian

samples have a preponderance of *Relbunium,* a plant which is not as common in the landscape as its proportion in the dung would suggest. However, the remaining seed taxa do reflect the grassland habitats in which the animals like to feed. The presence of certain species may also represent the season during which the dung was deposited. Provisioning animals with fodder, such as we see today with animals given totora reeds (*Scirpus* sp., Cyperaceae), could skew the interpretation of the ecological zones the camelids were using.

This study of seeds obtained from dung samples and the models we have constructed of how those seeds might enter the archaeological record represent an important step in learning to deal with those small, dense, weedy seeds that make up the majority of archaeological flotation samples in the south central Andes, as in other xerophytic places of the world. The patterns of seeds we have identified may contribute to the analysis of past landscape use, foddering activities, camelid husbandry, as well as dung use at archaeological sites.

ACKNOWLEDGEMENTS

This research was funded by the National Science Foundation BNS 84-51369. The laboratory research was completed in the Archaeobotany Laboratory at the University of Minnesota, Minneapolis. We would like to thank John Petroskis, Sissel Johannessen, Heidi Lennstrom, and Kate Moore for their help with this project. We would also like to thank the reviewers of this manuscript for their helpful and perceptive suggestions. Miriam Doutriux translated the abstract into French and Soñia Alconini into Spanish.

NOTES

[1]Work at Tiwanaku was undertaken under the auspices of Proyecto Wila Jawira, co-directed by Prof. Alan Kolata of the University of Chicago and Oswaldo Rivera S of the Instituto Nacional de Arqueología de Bolívia. Systematic soil samples of 6-8 liters were taken from every level and every feature during the excavations in 1989, 1990, and 1991. These were processed with a mechanized flotation machine (modified after Watson 1976), and the light and heavy fractions were sorted and botanical remains greater than 0.5 mm extracted and where possible identified, to family if not to genus. All flotation and analysis procedures are described in greater detail in Wright et al, in press.

LITERATURE CITED

BROWMAN, DAVID L. 1986. Chenopod cultivation, lacustrine resources, and fuel use at Chiripa, Bolivia. *In* New World Paleoethnobotany: Collected Papers in Honor of Leonard Blake. Missouri Archaeologist 47:137-172.

BRYANT, F.C. and R. D. FARFAN. 1984. Dry season selection by Alpaca (*Lama pacos*) in southern Peru. Journal of Range Management 37(4):330-333.

CHAVÉZ, KAREN. 1986. Traditional pottery of Raqchi, Cuzco, Peru: A preliminary study of its production, distribution and consumption. Nawpa Pacha 22-23:161-210.

FLANNERY, KENT V., JOYCE MARCUS, and ROBERT G. REYNOLDS. 1989. Flocks of the Wamani, a study of llama herders on the punas of Ayacucho, Peru. Academic Press, San Diego.

HASTORF, CHRISTINE A. 1993. Agriculture and the Onset of Political Inequality Before the Inka, Cambridge University Press, Cambridge.

HEYNE, CATHERINE. 1992. Identification of wood samples from Cachi, Argentina. Bachelor's thesis, Department of Anthropology, University of Minnesota, Minneapolis.

HILLMAN, GORDON C., ANTHONY J. LEGGE, and PETER A. ROWLEY-CONWAY. 1997. On the charred seeds from Epipaleolithic Abu Hureyra: Food or fuel? Current Anthropology 38(4):651-655.

JOHANNESSEN, SISSEL and CHRISTINE A. HASTORF. 1990. A history of fuel management (A.D. 500 to the present) in the Mantaro Valley, Peru. Journal of Ethnobiology 10(1):61-90.

LENNSTROM, HEIDI A. 1991. Intrasite spatial variability and resource utilization in the prehistoric Peruvian highlands: An exploration of method and theory in paleoethnobotany. Ph.D. dissertation, Center for Ancient Studies, University of Minnesota.

MILLER, NAOMI F. 1984. The use of dung as fuel: An ethnographical example and an archaeological application. Paleorient 12:71-79.

——— 1997. Reply to Hillman, Legge, and Rowley-Conway. On the charred seeds from Epipaleolithic Abu Hureyra: Food or fuel? Current Anthropology 38(4):655-659.

MILLER, NAOMI F. and KATHRYN L. GLEASON. 1994. Fertilizer in the identification and analysis of cultivated soil. Pp. 25-43 *in* The Archaeology of Garden and Field, N. F. Miller and K. L. Gleason (editors). University of Pennsylvania Press, Philadelphia.

MILLER, NAOMI F. and TRISTINE L. SMART. 1984. Intentional burning of dung as fuel: A mechanism for the incorporation of charred seeds into the archaeological record. Journal of Ethnobiology 4:15-28.

PEARSALL, DEBORAH M. 1983. Evaluating the stability of subsistence strategies by use of paleoethnobotanical data. Journal of Ethnobiology 3(2):121-137.

——— . 1988. Interpreting the meaning of macroremain abundance: The impact of source and context. Pp. 97-118 *in* Current Paleoethnobotany, C. A. Hastorf and V. S. Popper (editors). University of Chicago Press, Chicago.

——— . 1989. Adoption of prehistoric hunter-gatherers to the high Andes: The changing role of plant resources. Pp. 318-332 *in* Foraging and Farming: The Evolution of Plant Exploitation, D. R. Harris and G. C. Hillman (editors). Unwin Hyman, London.

PULGAR VIDAL, JAVIER. 1946. Geográfica del Perú. Las Ocho Regiones Naturales del Perú. Lima.

SIKKINK, LYNN. 1988. Traditional crop-processing in central Andean households: An ethnoarchaeological perspective. *In* Multidisciplinary Studies in Andean Anthropology, V. Vitzhulm (editor). Michigan Discussions in Anthropology, vol. 8. University of Michigan, Ann Arbor.

SILLAR, WILLIAM. 1994. Pottery's role in the reproduction of Andean society. Ph.D. dissertation, Department of Archaeology, University of Cambridge, Cambridge, England.

TOSI, JOSEPH A., JR. 1960. Zonas de vida natural en el Perú: Memoria explicativa sobre el mapa ecológico del Perú. Instituto Interamericano de Ciencias Agrícolas de la O.E.A., Zona Andina. Boletin Technico 5.

WATSON, PATTY JO. 1976. In pursuit of prehistoric subsistence: A comparative account of some contemporary flotation techniques. Midcontinental Journal of Archaeology 1:77-100.

WEBERBAUER, AGUSTO. 1945. El mundo vegetal de los Andes Peruanos. Estudio Fitogeográfico. Estación Experimental Agrícola. La Molina, Lima, Peru.

WINTERHALDER, BRUCE, ROBERT LARSEN, and R. BROOKE THOMAS. 1974. Dung as an essential resource in a highland Peruvian community. Human Ecology 2:889-104.

WRIGHT, MELANIE, CHRISTINE A. HASTORF, and HEIDI A. LENNSTROM. In press. Andean civilization through paleoethnobotanical eyes: Prehispanic plant use and agricultural production at Tiwanaku. *In* Tiwanaku and Its Hinterlands, Alan Kolata (editor). Smithsonian Institution Press, Washington, D.C.

APPENDIX 1A. — Raw data.

no.	taxa	region	wt (gm)	time (min)	atmos	relbun	smlgrass	cactus	unid	malvac	fabac	cheno	lrggrass	cyperac	u312
1	camelid	Bolivia	10	5	O	1			5		1				
2	camelid	Bolivia	10	6	O	10	4			1		3			
3	camelid	Bolivia	10	240	R	15	4		5	3			2		
4	camelid	Bolivia	10	5	O	17	2		7		1		3		
5	camelid	Bolivia	10	210	R	8	3					1			
6	camelid	Bolivia	10	0	U	14	6		5				2		
7	camelid	Bolivia	10.7	4	O	26	6		3	2	2		2		
8	camelid	Bolivia	10.2	5	O	19	5		7	3					
9	camelid	Bolivia	9.8	6	O	20	3				1		1		
10	camelid	Bolivia	10.3	6	O	27	4						2		
11	camelid	Bolivia	10.2	5	O	14	4		1	1					
12	camelid	Peru	10.1	6	O		8		2		1	1	1		
13	camelid	Peru	9.9	5	O	1	20		1		3				2
14	camelid	Peru	10.1	5	O	1	11		1		1	1		1	2
15	camelid	Peru	10.1	5	O		5		2		1	1			3
16	camelid	Peru	10	5	O	2	10		1		4			5	3
17	camelid	Peru	10	5	O		37		1		1	1		2	
18	camelid	Peru	10	4	O		2				2				
19	guinea pig	Peru	10	6	O										
20	guinea pig	Peru	10	4	O										
21	guinea pig	Peru	10	140	R										
22	guinea pig	Peru	10	5	O										
23	guinea pig	Peru	10	0	U										
24	goat	Argentina	10.1	6	O	2	3	7				1			
25	goat	Argentina	10	6	O	2	2	23				3		1	
26	goat	Argentina	10	5	O		1	47	2			4		4	
27	camelid	Bolivia	10	5	O	9	2			1					
28	camelid	Bolivia	9.9	5	O	14	2		1	4	1				
29	camelid	Bolivia	10	5	O	18	4			1	1		1		
30	camelid	Bolivia	10	4	O	32				5	1				
31	camelid	Bolivia	10.2	4	O	2	5					3			

APPENDIX 1B. — Raw Data.

no.	taxa	region	lump	plantago	u270	wirakoa	crucifer	medgrass	lrgsolan	borage	u280	smlsolan	pick (gm)	remain (gm)
1	camelid	Bolivia	3										0.04	
2	camelid	Bolivia	1						1				0.07	
3	camelid	Bolivia											0.05	
4	camelid	Bolivia		1									0.04	
5	camelid	Bolivia					1						0.03	
6	camelid	Bolivia					2						0.07	10
7	camelid	Bolivia	1	1						1			0.13	
8	camelid	Bolivia	1									1	0.05	4.9
9	camelid	Bolivia						2					0.03	4.47
10	camelid	Bolivia											0.03	4.85
11	camelid	Bolivia			1								0.05	4.99
12	camelid	Peru											0.05	2.6
13	camelid	Peru		1				1					0.05	3.19
14	camelid	Peru			1								0.09	2.88
15	camelid	Peru		1									0.04	2.75
16	camelid	Peru											0.03	2.9
17	camelid	Peru				4							0.06	1.59
18	camelid	Peru											0.01	3.59
19	guinea pig	Peru											0	2.63
20	guinea pig	Peru											0	2.06
21	guinea pig	Peru											0	5.01
22	guinea pig	Peru											0	2.04
23	guinea pig	Peru											0	10
24	goat	Argentina			2						1		0.02	2.11
25	goat	Argentina								1			0.06	2.4
26	goat	Argentina									1		0.04	2.3
27	camelid	Bolivia							1				0.01	4.3
28	camelid	Bolivia											0.02	3.58
29	camelid	Bolivia		1									0.04	4.14
30	camelid	Bolivia											0.03	6.57
31	camelid	Bolivia											0.01	3.08

Key to Appendix 1: no = sample number of the dung sample; atmos = burning atmosphere, O= oxidizing, R= reducing, U= unburnt; relbun = *Relbunram*; smlgrass = small Poaceae; cactus = Cactaceae; unid = unidentifiable seed; malvac = Malvaceae; fabac = Fabaceae (wild legume); cheno = *Chenopodium* spp.; lrggrass = large Poaceae; cyperac = Cyperaceae (sedge); u312 = unknown seed, type #312; lump = lump of burned non-woody paraenchymous material; plantago = Plantaginaceae; u270 = unknown seed, type # 270; wirakoa = as yet unidentified plant used by the Bolivian Aymara as incense; crucifer = Cruciferae; medgrass = medium Poaceae; lrgsolan = large Solanaceae; borage = Boraginaceae; u280 = unknown seed, type # 280; smlsolan = small Solanaceae; pick (gm) = weight of the separated seeds in grams; remain (gm) = weight of the remains once the seeds had been picked out in grams.

Plantas de los Dioses: Orígenes del Uso de los Alucinógenos [Plants of the Gods: Origins of the Use of Hallucinogens]. Richard Evans Schultes and Albert Hofmann. Mexico City, Mexico: Fondo de Cultura Economica, Carr. Picacho-Ajusco No. 227, 14200 Mexico, D.F. 1993. Pp. 192. US$30.00 [approx.] (clothbound with D/J); numerous color and B/W illustrations; 1 pp. bibliography of 79 sources; 5 pp. index. ISBN 968-16-1023-7. **Pflanzen der Götter: Die magischen Kräfte der Rausch- und Giftgewächse [Plants of the Gods: The Magical Powers of Toxic and Inebriating Herbs].** Richard Evans Schultes and Albert Hofmann. Aarau, Switzerland: AT Verlag, Bahnhofstrasse 39-43, CH-5001. 1995. Pp. 192. SF48.00/ DM48.00/ÖS375.00 (clothbound with D/J); numerous color and B/W illustrations; 1 pp. bibliography of 79 sources; 4 pp. index). ISBN 3-85502-543-6.

In addition to the 1992 paperback reprint of *Plants of the Gods,* the classic 1979 coffee-table book on shamanic inebriants by noted pioneers in the field, Richard Evans Schultes and Albert Hofmann (*vide* my review in *Journal of Ethnobiology* 14(1):132-134, 1994), and the 1993 French translation of same, *Les Plantes des Dieux,* there have now appeared clothbound reprints both of the 1982 Spanish translation, *Plantas de los Dioses,* and the 1980 German translation, *Pflanzen der Götter.* All of these editions, save the 1979 original, have been produced by EMB-Service for Publishers in Luzern, no doubt to achieve economies of scale in printing the 44 full-color pages, subsequently crash-imprinting the text in diverse languages. The quality of paper and color printing is therefore uniform, regardless of the language, at least with respect to the illustrative material. The new Spanish edition is an exact copy of the English first edition, even down to the design of the dust-jacket and foil cover-stamping; whereas this new German translation has redesigned front- and back-matter and a different dust-jacket, featuring a Huichol yarn painting from page 184, showing *a peyotl* (*Lophophora williamsii* (Lemaire) Couiter) *nierika* or 'portal between worlds'. I refer the reader to my review of the 1992, English paperback reprint (cited above) for a description of the contents of the book. Although *Plants of the Gods* is manifestly a visual feast for the senses, and an introduction to the subject of shamanic inebriants for the general reader, as I have noted, "it contains many nuggets of ethnobotanical data of compelling interest to the specialist, which are not to be found in any other publication by either author." It is regrettable that, in at least six translations and/or reprints of the original book over 16 years [1 English, 2 Spanish, 2 German, 1 French], the obvious transposition of two figure-legends for the molecular models on page 174 (*iso*-LSD and lysergic acid hydroxyethylamide) remains uncorrected. It is indeed fortunate, however, that this important general readers' and specialists' book on the enduring and fundamental subject of visionary plants remains in print in English, French, German, and Spanish.

Jonathan Ott, President
Natural Products Co.
Apartado Postal 532
Xalapa, Veracruz, México

Journal of Ethnobiology 18(2):229-245 Winter 1998

TESTING PRAIRIE PLANTS WITH ETHNOBOTANICAL IMPORTANCE FOR ANTI-CANCER AND ANTI-AIDS COMPOUNDS

KELLY KINDSCHER
Kansas Biological Survey
University of Kansas
2041 Constant Ave
Lawrence, KS 66047-2906

KIRK P. MANFREDI
MELISSA BRITTON
MARIA DEMIDOVA
Department of Chemistry
University of Northern Iowa
Cedar Falls, IA 50614

AND

DANA P. HURLBURT
Department of Systematics and Ecology
University of Kansas
Lawrence, KS 66045

ABSTRACT. — Literature research into ethnobotanical uses of North American prairie plants by Native Americans and early written accounts by travelers and doctors identified 203 native prairie species that have been used for medicine. We collected, identified, and made extracts from 22 of these species and subjected the extracts to biological screens to identify new anti-HIV and anti-cancer chemical leads. Our results show greater rates of activity for both aqueous extract anti-AIDS screens (60.0%) and organic extract anti-AIDS screens (13.6%) than rates previously determined through random screening of terrestrial plants (13.9% and 3.0%, respectively). In preliminary anticancer screening, 10 of 22 organic extracts showed at least moderate activity. This work demonstrates that native prairie plants (and probably those of other regions in North America) may provide new chemical leads, especially if the target list includes those species that have ethnobotanical use histories. We also believe that our work helps substantiate the idea that Native Americans were choosing many plants with pharmacologically active substances in their health and healing practices.

RESUMEN. — Una investigación bibliográfica acerca de los usos etnobotánicos de plantas de las praderas norteamericanas por parte de los indígenas, y las descripciones tempranas de viajeros y médicos, identificó 203 especies nativas de la pradera que han sido usadas como medicinas. Colectamos, identificamos y preparamos extractos de 22 de estas especies y sometimos los extractos a pruebas biológicas para indentificar nuevos candidatos químicos contra el SIDA y el cáncer. Nuestros resultados muestran tasas mayores de actividad anti-SIDA tanto en pruebas con extractos acuosos (60.0%) como extractos orgánicos (13.6%) que las tasas previamente determinadas a través de pruebas con plantas terrestres

seleccionadas al azar (13.9% y 3.0%, respectivamente). 10 de 22 extractos orgánicos mostraron por lo menos actividad moderada en pruebas preliminares anti-cáncer. Este trabajo demuestra que las plantas nativas de la pradera (y probablemente las de otras regiones de Norteamérica) pueden proporcionar nuevos candidatos químicos, especialmente si la lista seleccionada incluye aquellas especies que tienen una historia de uso etnobotánico. Creemos también que nuestro trabajo ayuda a substanciar la idea de que los indígenas norteamericanos estaban escogiendo en sus prácticas de salud y curación muchas plantas con sustancias farmacologicamente activas.

RÉSUMÉ.— Une recherche bibliographique sur les utilisations ethnobotaniques des plantes des prairies nord-américaines par les Amérindiens ainsi que les premiers écrits des voyageurs et médecins a permis d'identifier 203 espèces indigènes des prairies qui étaient utilisées comme médicaments. Nous avons collecté, identifié et préparé des extraits de 22 de ces espèces et avons soumis ces extraits à des examens biologiques pour identifier de nouveaux agents chimiques anti-V.I.H. et anti-cancéreux. Nos résultats montrent des taux d'activité plus élevés pour les examens des extraits aqueux antisida (60,0%) et pour les examens des extraits organiques antisida (13,6%) que les taux déterminés antérieurement par des examens de plantes terrestres faits au hasard (33,8% et 4,2% respectivement). Dans nos examens préliminaires anti-cancéreux, 10 des 22 extraits organiques ont montré une activité au moins modérée. Ce travail démontre que les plantes indigènes des prairies (et probablement celles d'autres régions d'Amérique du Nord) peuvent fournir de nouveaux agents chimiques, particulièrement si on inclut dans la liste cible les espèces qui ont une histoire ethnobotanique. Nous croyons aussi que notre travail vient soutenir l'idée que les Indiens d'Amérique choisissaient plusieurs plantes aves des substances pharmacologiques actives dans leurs pratiques hygiéniques et thérapeutiques.

INTRODUCTION

Literature research into the ethnobotanical uses of prairie plants by Native Americans, early travelers, traders, settlers, and doctors has identified 203 native prairie species that were used for medicinal purposes (Kindscher 1992) and 123 species that were used for food (Kindscher 1987) in the Prairie Bioregion (Figure 1). Conservation of tropical rain forests receives considerable attention because of the probable value of potential pharmaceutical agents (Balick and Mendelsohn 1992; Farnsworth and Soejarto 1991; Hodson, Englander, and O'Keefe 1995), and the National Cancer Institute's current large-scale plant collecting and screening program is focused on the tropics. By contrast, few prairie plants have ever been considered for use by the contemporary health industry (Kindscher 1992; Tyler 1993). We believe that this is an untapped resource that should be explored further.

Several authors have obtained a higher proportion of active extracts from ethnobotanically targeted as opposed to random plant collections (Balick 1990; Cox *et al.* 1989; Lewis and Elvin-Lewis 1995; Spjut and Perdue 1976). McCutcheon *et al.* (1992, 1994) demonstrated that there is value in studying temperate North American plants for medicinal purposes. They determined that 85% of 96 extracts of native plants of British Columbia with reported ethnobotanical uses exhibited

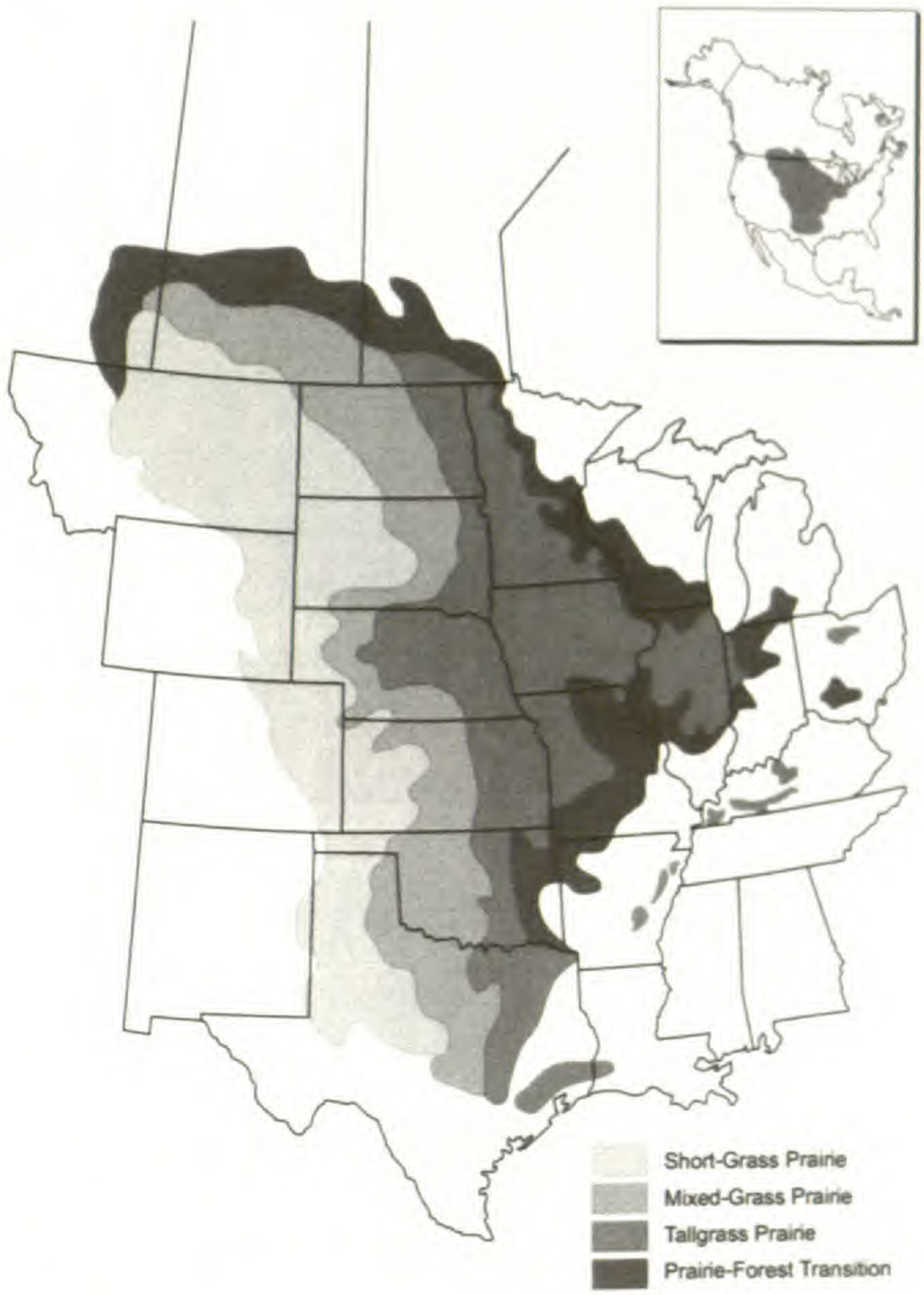


FIGURE 1. — Map of the Prairie bioregion

antibiotic activity (McCutcheon *et al.* 1992) and that 81% of these plant extracts exhibited antifungal activity (McCutcheon *et al.* 1994). They also recognized that the appeal of tropical ethnobotany had not extended to temperate North America, but asserted that the North American flora is worthy of ethnobotanically-based medicinal product exploration.

We conducted our study to: a) highlight the potential economic value of prairie and prairie plants; b) screen these plants for potential anti-HIV and anti-cancer bioactivity; and c) to determine if a greater number of plants with potential bioactivity can be found by choosing species that have an ethnobotanical history of use by Native Americans than by random screenings. While we knew it was unlikely that we would find a plant that was a cancer or AIDS cure, we hoped to show the promise of building upon the knowledge of Native Americans.

TABLE 1. — Ethnobotanical uses of prairie plants tested in anti-AIDS and anti-cancer screens. Scientific names of plants, families, collection numbers, common names, code for tribes that used the plant (code is below), references, and ailments treated by the tribes. Tribal Codes: AR, Arapaho; AS, Assiniboin; BA, Bannocks; BL, Blackfoot; CE, Cree (Plains); CH, Cheyenne; CO, Comanche; CK, Choctaws; CR, Crow; FH, Flathead; GR, Gros Ventre; KA, Kiowa-Apache; KI, Kiowa; KU, Kutenais; ME, Meskwaki (Fox); MN, Menomini; NP, Nez Perce; OJ, Ojibwa (Chippewa); OM, Omaha; OS, Osage; PA, Pawnee; PO, Ponca; PW, Potawatomi; SH, Shoshones; SI, Sioux; SI-DA, Dakota Sioux; SI-LA, Lakota Sioux; TE, Tewa; WI, Winnebago; ZU, Zuni.

Scientific Name	Common Name	Tribes (References)	Ailments and Uses
Achillea millefolium L. (ASTERACEAE) (Loring 01)	Yarrow	AS (Shemluck 1982); BL (Hellson 1974); CH (Grinnell 1962); CR GR (Shemluck 1982; SI-LA (Buechel 1983); OS (Munson 1981; PA (Dunbar 1880); WI (Gilmore 1977).	boils; burns; colds; coughing and throat irritations; diuretic; earaches; fainting; fever; general external afflictions; heart trouble and chest pains; open sores; respiratory diseases like tuberculosis; stomach com plaints; stops bleeding; swelling; toothache and sore gums; treat wounds.
Amorpha canescens Pursh (FABACEAE) (Loring 02)	Leadplant	AS (Bray & Bray 1976); SI-LA (Rogers 1980);ME (Smith 1928); OM (Gilmore 1977);PO (Gilmore 1977); PW (Smith 1933).	astringent for cuts and open wounds; eczema; intestinal worms; neuralgia; rheumatism.
Astragalus bisulcatus[1] (Hook.) A.Gray (FABACEAE) (Loring 03)	Milkvetch	BL (Hellson 1974); CH (Grinnell 1962); SI-DA (Gilmore 1977);SI-LA (Rogers 1980);OM PO (Gilmore 1977).	applied to cuts; chest and back pains; coughing; febrifuge for children; heart troubles; loss of appetite; poison ivy and other plant dermatitis; promotes milk production in mothers; spitting of blood; stomach pains.
Ceanothus herbaceus[2] Raf. var. *pubescens* (T. & G.) Shinners (RHAMNACEAE) (Loring 04)	New Jersey Tea	AR (Nickerson 1966); CK (Bushnell 1909); PW (Smith 1933). OJ (Densmore 1974); SI-DA (Bray & Bray 1976); SI-LA (Rogers 1980); ME MN OJ PW (Smith 1928); SH (Nickerson 1966).	chest colds; hemorrhage from the lungs; stomach and bowel troubles.
Conyza canadensis (L.) Cronq. (ASTERACEAE) (Loring 05)	Horseweed	SI-LA (Rogers 1980; Munson 1981); ME (Smith 1928); ZU (Stevenson 1915).	bowel pain and diarrhea, particularly in children; rhinitis.
Equisetum hyemale L. (EQUISETACEAE) (Loring 06)	Horsetail	BL (Hellson 1974); CE (Johnston 1970); ME (Smith 1928); MN (Smith 1923); TE (Youngken 1925).	clear up system after childbirth; cold and diarrhea remedy for babies; diuretic; gonorrhea; kidney troubles; menstrual irregularities; rashes under arm and in the groin.

Fragaria virginiana Duchn. (ROSACEAE) (Loring 07)	Wild Strawberry	BL (Hellson 1974); OJ PW (Smith 1932 1933).	diarrhea; stomachache in babies; stomach complaints; summer cholera that affected young children.
Glycyrrhiza lepidota Pursh (FABACEAE) (Hurlburt 32)	Wild Licorice	BA (Murphey 1959); BL (Hellson 1974); CH (Hart 1981); SI-LA (Munson 1981); PA (Gilmore 1914; Kindscher 1987). ZU (Camazine & Bye 1980)	chest pains and sore throat; cough; diarrhea and upset stomach; earache; fever in children; flu; spitting of blood; swellings; toothache.
Helianthus grosseserratus Martens (ASTERACEAE) (Loring 08)	Sawtooth Sunflower	ME (Smith 1928);ZU (Camazine & Bye 1980).	burns; rattlesnake bites.
Ipomoea leptophylla Torr. (CONVOLVULACEAE) (Hurlburt 30)	Bush Morning Glory	SI-LA (Rogers 1980); PA (Gilmore 1977).	fainting; nervousness and bad dreams; pain; stomach trouble.
Juniperus virginiana L. (CUPRESSACEAE) (Loring 09)	Eastern Red Cedar	BL (McClintock 1909; Johnston 1970; Hellson 1974); CH (Grinnelll 1962); CR (Hart 1976); SI-DA (Gilmore 1977); FH (Hart 1976); GR (Kroeber 1908); KI (Vestal & Schultes 1939); KU (Hart 1976);SI-LA (Gilmore 1977); ME (Smith 1928; NP (Hart 1976); OM (Fletcher & LaFlesche 1911); PA (Gilmore 1977); SI (Hart 1976).	arthritis; asthma; canker sores; cholera; cleansing and healing for women after childbirth; colds; control bleeding; convalescent; coughs; diarrhea; external sores; fevers; lung troubles; nervousness and bad dreams; pneumonia; rheumatism; sedative; speed childbirth; stiff back or backache; stop vomiting; tonic; tonsilitis; weakness.
Liatris punctata Hook. (ASTERACEAE) (Loring 10)	Gayfeather	BL (McClintock 1923); CO (Carlson & Jones 1939); KA (Jordan 1965); SI-LA (Rogers 1980); ME (Smith 1928); OM PA (Gilmore 1977); PW (Smith 1933). PO (Gilmore 1977); PW (Smith 1928).	abdominal troubles; bladder and kidney troubles; bloody urine; diarrhea in children; external inflamation; external wounds; gonorrhea; heart pains; loss of appetite; scabies; stomachache; swellings; swollen testes.
Monarda fistulosa[3] L. (LAMIACEAE) (Loring 11)	Beebalm	BL (McClintock 1923; Hellson 1974); CR (Hart 1976); SI-DA (Gilmore 1977; Andros 1883); FH (Blankenship 1905; Dunbar 1880); KI (Vestal & Schultes 1939); SI-LA (Munson 1981; Rogers 1980); ME (Smith 1928); PA (Dunbar 1880); SI (Blankenship 1905); WI (Gilmore 1977; Andros 1883).	abdominal pain; after childbirth; boils; catarrh; cholera; colds; cuts; eyewash; fevers; fainting; headaches; induce vomiting; insect bites and stings; pimples; respiratory problems; revive unconscious patient; soothe kidneys; sore eyes; stop external blood flow; swollen neck glands; whooping cough and other coughs.
Oenothera rhombipetala Nutt. ex T. & G. (ONAGRACEAE) (Hurlburt 29)	Evening Primrose	OM (Gilmore 1977).	heals bruises; inflamation; swelling and sores.

Pediomelum argophyllum (Pursh) J. Grimes (FABACEAE) (Loring 12)	Wild Alfalfa	CH (Grinnell 1962); SI-DA (Rogers 1980); ME (Smith 1928).	chronic constipation; external wounds; fever; horse medicine.
Pycnanthemum tenuifolium[4] Schrad. (LAMIACEAE) (Loring 13)	Mountain Mint	SI-LA (Rogers 1980); ME (Smith 1928).	ague; alterative; chills; coughing.
Rhus glabra L. (ANACARDIACEAE) (Loring 14)	Smooth Sumac	KI (Vestal & Schultes 1939); ME (Smith 1928);OM (Gilmore 1977; 1913a);OS (Wakefield & Dellinger 1936); PA (Gilmore 1977; 1913a).	appetizer; astringent; bloody diarrhea; painful menstruation; urination and retention of water; rubefacient; tuberculosis; wash sores.
Rubus flagellaris Willd. (ROSACEAE) (Loring 15)	Black Raspberry	OS (Hunter 1957).	abdominal pains; children with bowel trouble.
Silphium laciniatum L. (ASTERACEAE) (Loring 16)	Compass Plant	CR (Vogel 1970); ME (Smith 1928); OM PA PO SI-DA (Gilmore 1977).	emetic; general debility; head colds; rid horses of worms.
Silphium perfoliatum L. (ASTERACEAE) (Loring 17)	Cup Plant	ME MN OJ (Smith 1928, 1932); OM PO (Gilmore 1977); PW (Smith 1933); WI (Gilmore 1977).	alleviate vomiting during pregnancy; emetic; head colds; nerve pains; profuse menstruation; rheumatism
Solidago canadensis L. (ASTERACEAE) (Loring 18)	Goldenrod	ME (Smith 1928).	kidney trouble.
Verbena hastata L. (VERBENACEAE) (Loring 19)	Blue Vervain	OJ (Densmore 1974); SI-DA (Gilmore 1977);ME (Smith 1928); MN (Smith 1923); OM (Gilmore 1977).	cloudy urine; fits; nosebleed; stomachache.

[1]No specific reference to this species, so tribes and ailments used from related species: *Astragalus adsurgens, A. canadensis, A. gracilis,* and *A.racemosus.*

[2]Tribes and ailments used from related species, *Ceanothus americanus.*

[3]For *Monarda fistulosa*, the Pawnee recognized four "species," while the Dakota, Omaha, and Ponca recognized two (Gilmore 1977). Since we only recognize one today, these uses are combined.

[4]Related species *Pycnanthemum virginianum* used for tribes and ailments.

METHODS

Plant collection. — Prairie plants (native species of grasses, forbs, and woody shrubs in the Prairie Bioregion; see Figure 1) were selected based on their ethnobotanical use (Table 1) and availability for collection while in flower. These 22 species represent 11 families and include six species of the Asteraceae and four of the Fabaceae (two of the largest families of prairie plants). Plant identification follows the *Flora of the Great Plains* (Great Plains Flora Association 1986) and nomenclature follows Kartesz (1996). Voucher specimens of all species collected are archived at the R.L. McGregor Herbarium at the University of Kansas. At least 2 kg of each species was harvested and air dried and subsequently shipped to the Chemistry Laboratory at the University of Northern Iowa.

Extraction. — The plant material (leaves, stems, or roots) was chopped into small pieces, placed in a small cloth sack and immersed in liquid nitrogen. Once completely frozen, samples were crushed and placed in a large beakers filled with CH_2Cl_2 and MeOH (1:1) and covered. After 24 hours the solvent was drained off and the plants were covered with pure MeOH. After an additional 24 hours, the MeOH was drained, combined with the CH_2Cl_2:MeOH extract, and the solvent was removed at reduced pressure using a rotary evaporator. The resultant solid material was designated the "organic extract." The remaining plant material was covered with water for an additional 24 hours, the water was drained and the resultant extract was placed on a rotary evaporator for a few minutes to remove any traces of organic solvent. The water was then quickly frozen in a CO_2 - acetone bath and freeze-dried. This extract was referred to as the "aqueous extract."

Anti-HIV testing. — The anti-HIV assay was carried out at the Laboratory of Drug Discovery Research and Development at the US National Cancer Institute (NCI) as described previously (Weislow *et al.* 1989). Since this was a preliminary screening, each plant extract was tested in duplicate rather than replicating the tests with many different samples. The assay tests the ability of plant extracts to inhibit the killing of T4 (CD4+) lymphoid cells (CEM-SS line) by HIV-1 (RF strain). Samples of 5.0 mg of extract were dissolved in 100 ml of dimethylsulfoxide and diluted in a cell assay to give a maximum test concentration of 250 mg/mL of cells. The extract was then serially diluted to a minimum concentration of 0.0079 mg/mL. The exponentially-growing cells were pelleted from the growth medium and infected at a multiplicity of infection of 0.05 at room temperature for 45 minutes with constant agitation. The cells were then diluted in growth medium to the desired cell concentrations to yield 5,000 cells/well after inoculation and inserted into wells of 96 micro-titer plates. Equal aliquots (50 mL) of the test solutions containing the plant extracts were added to the appropriate wells, and the plates were incubated for 6 days at 37° C. Plates were then analyzed for cellular viability using the XTT-tetrazolium method (Weislow *et al.* 1989).

The assay provides three important parameters. The EC_{50} is the concentration of extract at which the growth of the infected cells is 50% of the non-infected, extract-free control. The IC_{50} is the concentration at which the growth of non-infected white blood cells containing the extract is 50% of the control, and measures the extract's toxicity to healthy cells. The TI_{50} is the ratio of the EC_{50} to the IC_{50} and

can be considered a measurement of viricidal activity relative to cytotoxicity. A larger TI_{50} value represents a more viable drug candidate.

These tests are considered a preliminary screen; therefore, exact quantification of the EC_{50}, IC_{50}, and TI_{50} values is inappropriate at this stage. In reporting the results of the assay, we classify the extracts as "active," "moderate," or "inactive." We define an "active" extract as one that achieves an EC_{50} value at a concentration less than 250 mg/mL and an extract with "moderate" activity as one which shows growth of infected cells at less than a 50% value. An "inactive" extract either fails to enable infected cells to grow or is toxic to the uninfected control cells at concentrations less than 250 mg/mL.

To test whether the rate of activity obtained from our ethnobotanically-selected sample was different from that expected from a random sample of plants, we used expected frequencies obtained in the NCI's large-scale "modified random" screening program, which included both medicinal and non-medicinal plants (Lewis and Elvin-Lewis 1995). Because of our small sample sizes and the small expected number of active extracts, we calculated the exact binomial probabilities (of obtaining results equal to or better than ours) (Sokal and Rohlf 1995) using QuattroPro software (Novell, Inc. 1994).

Anti-cancer screening. — Anti-cancer screening was carried out at Laboratory of Drug Discovery Research and Development. The two-day bioassays using 60 human tumor cell lines were performed as described previously (Boyd 1989). Each extract was tested at a maximum concentration of 250 mg/mL of cells and serially diluted to a minimum concentration of 0.018 mg/mL. The cells were allowed to incubate for 48 hours, at which time cell growth was measured as described in Boyd (1989). Three parameters were then measured: GI_{50} (the concentration of extract at which 50% of the tumor cells are inhibited in their growth relative to non-extract treated cells), GI_{100} (the concentration at which 100% of the tumor cells' growth has been inhibited), and LC_{50} (the concentration of extract at which 50% of the tumor cells are killed relative to the control). In addition to these three parameters, specificity was also measured. Specificity is observed when an extract demonstrates an exceptional amount of activity for one particular cell line relative to the others. Usually this activity is at least one order of magnitude greater than that for the average of all other cell lines. The human tumor cell lines tested were: leukemia, non-small cell lung, colon, central nervous system, melanoma, ovarian, renal, prostate, and breast. A thorough discussion of data interpretation from the National Cancer Institute screen can be found in Boyd and Paull (1995).

Like the anti-HIV assay, the anti-cancer assay was run in duplicate with the same sample. We will again use "active," "moderate," and "inactive" to report our results. Samples that achieve an LC_{50} with at least 50% of the cell lines responding will be classified as "active," while extracts with "moderate" activity must achieve an LC_{50} with at least 20% of the cell lines tested responding.

TABLE 2. — Results of anti-HIV assay for prairie plants. A = "active" extract (achieves $EC_{50,}$ test concentration at which growth of infected cells is 50% of non-infected control); M = "moderate" activity (extract shows growth of infected cells at less than 50% of control); I = "inactive" (extract shows no growth of infected cells or toxicity to uninfected control cells at concentration less than 250 mg/ml); T= toxic to uninfected control cells at very low concentration. Overall rate of activity is 60.0% for aqueous extracts and 13.6% for organic extracts.

Scientific Name	Aqueous	Organic
Achillea millefolium	A	M
Amorpha canescens	A	I
Astragalus bisulcatus	I	I
Ceanothus herbaceus	A	I
Conyza canadensis	A	M
Equisetum hyemale	I	I
Fragaria virginiana	I	I
Glycyrrhiza lepidota	I	A
Helianthus grosseserratus	A	I
Ipomoea leptophylla	A	A
Juniperus virginiana	T	I
Liatris punctata	A	I
Monarda fistulosa	A	I
Oenothera rhombipetala	A	A
Pediomelum argophyllum	not tested	I
Pycnanthemum tenuifolium	A	I
Rhus glabra	not tested	M
Rubus flagellaris	A	I
Silphium laciniatum	A	I
Silphium perfoliatum	I	M
Solidago canadensis	I	I
Verbena hastata	I	I

RESULTS

Anti-HIV aqueous assay. — Aqueous extracts of 20 of the 22 plants collected were tested for anti-HIV activity. Twelve extracts met the criteria for "active" (Table 2). *Juniperus virginiana* showed an exceptionally low IC_{50} (the concentration at which 50% of the non-infected white blood cells are killed), but showed no protection to infected cells. This indicates a very high toxicity to healthy cells. At the other end of the activity spectrum was *Oenothera rhombipetala,* which had the lowest EC_{50} concentration of 0.56 mg/ml. *Helianthus grosseseratus,* with a TI_{50} value of >250, never showed toxicity to uninfected cells. The 60.0% activity rate in these extracts is significantly higher ($p < .001$) than the 13.9% rate reported for terrestrial plants by the NCI in its large-scale screening program (Cardellina *et al.* 1993).

Anti-HIV organic assay. — Twenty-two organic extracts were tested for anti-HIV activity. Only three plants achieved an EC_{50} (*Ipomoea leptophylla, Glycyrrhiza lepidota,* and *Oenothera rhombipetala*). This results in 13.6% of the extracts being classified as "active," a proportion which is significantly greater ($p = .03$) than the 3.0% rate for

TABLE 3. — Results of anti-cancer screen for prairie plants. A = "active" extract (achieves LC_{50}, test concentration at which 50% of tumor cells are killed relative to control, with at least 50% of cell lines responding); M = "moderate"(achieves LC_{50} with at least 20% of cell lines responding); I = "inactive."

Scientific Name	Aqueous	Organic
Achillea millefolium	I	M
Amorpha canescens	I	I
Astragalus bisulcatus	I	I
Ceanothus herbaceus	slight activity	I
Conyza canadensis	I	I
Equisetum hyemale	I	I
Fragaria virginiana	I	I
Glycyrrhiza lepidota	I	M
Helianthus grosseserratus	I	A
Ipomoea leptophylla	I	A
Juniperus virginiana	I	A
Liatris punctata	I	M
Monarda fistulosa	I	M
Oenothera rhombipetala	I	I
Pediomelum argophyllum	not tested	I
Pycnanthemum tenuifolium	I	I
Rhus glabra	not tested	I
Rubus flagellaris	I	I
Silphium laciniatum	I	M
Silphium perfoliatum	I	M
Solidago canadensis	I	A
Verbena hastata	I	I

terrestrial plants reported by the NCI in their screening program (Cardellina *et al.* 1993). Four plants (*Achillea millefolium, Conyza canadensis, Rhus glabra,* and *Silphium perfoliatum*) showed moderate protection from the HIV virus in infected cells.

Anti-cancer aqueous screen. — Only one aqueous extract of the twenty tested, *Ceanothus herbaceus,* achieved an LC_{50} value. Its activity was slight, with only two of the 60 cell lines showing sensitivity to this extract.

Anti-cancer organic screen. — Twenty-two organic extracts were tested in the anti-cancer screen (see Table 3). Four extracts were active (*Helianthus grosseserratus, Ipomoea leptophylla, Juniperus virginiana,* and *Solidago canadensis*) and six extracts showed moderate activity (*Achillea millefolium, Glycyrrhiza lepidota, Liatris punctata, Monarda fistulosa, Silphium laciniatum,* and *Silphium perfoliatum*). This difference between activity of the organic and aqueous extracts may be due to the fact that the non-polar molecules of organic extracts more easily enter the cell through the non-polar cell membrane. *Juniperus virginiana* showed the highest activity. This extract achieved a GI_{50} and GI_{100} when tested with all 60 cell lines, while it achieved a LC_{50} with 83% of the cell lines. Its GI_{50} was 0.062 mg/mL. None of the plants tested met the criteria for specificity.

DISCUSSION

Although these are preliminary results from a small data set, we found that a relatively high proportion of prairie plants with historical ethnomedical uses were active in anti-cancer and anti-AIDS screening. Further testing is needed to quantify the data, including replication and testing with different cell lines and different viral strains of HIV.

The relatively high number of aqueous extracts we found to be active in the AIDS screen is likely to be due to the antiviral activity of sulfated polysaccharides (Beutler *et al.* 1993) or the potent reverse transcriptase inhibitors of polyphenolic tannins (Tan *et al.* 1991). Because these substances are already known and therefore are not of interest in the screening process (Cardellina *et al.* 1993), our active extracts should be further screened using alcohol mediated precipitation to eliminate the polysaccharides and polyamide adsorption to eliminate false positive results from tannins.

In the anti-cancer screen, *Juniperus virginiana* organic extract's GI_{50} of 0.062 mg/mL is impressively low in comparison with the value obtained for organic extract of *Camptotheca acuminata*. *Camptotheca* produces the known anti-tumor compound camptothecin and its GI_{50} was 3.0 mg/mL (Mike Boyd, personal communication, National Cancer Institute, 1997).

The failure of any of our extracts to meet the criteria for specificity is not surprising, since fewer than 1% of the plants tested by the NCI show evidence of selective cytotoxicity (Cragg *et al.* 1994). We would suggest that the ten extracts that achieved at least moderate activity should be further examined (*Achillea millefolium, Glycyrrhiza lepidota, Helianthus grosseserratus, Ipomoea leptophylla, Juniperus virginiana, Liatris punctata, Monarda fistulosa, Silphium laciniatum, Silphium perfoliatum*, and *Solidago canadensis*).

Several of the genera we tested were screened in the NCI's pre-1982 program and were excluded from further testing based on the large number of extracts screened (Spjut 1985). Our results show some anti-cancer activity for the organic extracts from these genera. Spjut stated that unless a different screening method were used, there were diminishing returns from additional collections of these genera. Our positive results suggest that re-evaluation of some of the plants tested before 1982 is merited. Ethnobotanical targeting may help identify promising candidates.

When comparing the rates of activity in a sample of ethnomedically targeted plants with a random sample, it is important that the term "activity" be clearly defined, and that the most appropriate data set be used for comparison. The most appropriate comparative data set for our work would have been a random sample of prairie plants, but we were unable to test the larger number of extracts that this would require. We chose to compare our percent of active extracts with the data from the NCI's primary AIDS screening program reported by Cardellina *et al.* (1993). These researchers, using data obtained through October 1992, reported that the proportion of terrestrial plants "selected for initial follow-up" was 13.9% for aqueous and 3.0% for organic extracts. Their criterion for activity was any extract achieving an EC_{50} at a concentration less than 250 mg/mL (Cardellina *et al.* 1993).

A more recent comparative data set is available in Cragg *et al.* (1994). This group, using data obtained through August 1993 (medicinal and non-medicinal plants combined), reported "percent active" rates of 33.8% for aqueous and 4.2% for organic extracts. The criterion for activity used by this group was any extract showing an EC_{50} at a concentration less than 1000 mg/mL (Gordon M. Cragg, personal communication, 1997). The difference in criteria used by these authors accounts for the difference in "percent active" from the two groups using the same assay. In our study we have used an EC_{50} concentration of <250 mg/mL to define our "percent active." Our data is therefore more comparable to Cardellina *et al.* (1993). Authors of other published literature have not always stated explicitly what criteria they used to determine whether or not a plant extract is "active," making comparisons between studies difficult.

Although several authors have attempted to show that ethnobotanically-targeted plant collections result in higher rates of active extracts being identified, the data from the NCI's large-scale screening program show no difference in rates of activity between medicinal plants and non-medicinal plants (Cragg *et al.* 1994). These data may seem discouraging to those who advocate using an ethnobotanical approach to collect plants in the search for new drugs, but we believe it means that ethnobotanists need to do a better job of targeting our collections and accurately matching ethnnomedical uses and practices to our screening methods. Balick (1994) suggests that the ethnobotanical approach will be most successful in small programs that are focused on collecting plants used by indigenous healers for the diseases they actually treat. Several authors have pointed out the difficulty in using ethnomedical data to identify anti-cancer agents, since cancer is not a well-defined disease in most traditional medical systems (Farnsworth 1990; Balick 1994). It is also important to attempt to match extraction procedures to the methods of administration used by healers so the active compounds actually used by healers are captured by the screening process (Cox 1990). Finally, it must be acknowledged that much of the historical ethnomedical information is poorly documented (Farnsworth 1990). It is not surprising that Lewis and Elvin-Lewis (1995) obtained a significantly higher rate of preliminary anti-AIDS activity in plants they selected based on primary (i.e., interviews) rather than secondary (i.e., literature and historical) ethnobotanical data, and specifically for traditional antiviral use as opposed to other ethnomedical uses. Primary data and specific uses are probably more accurate and reliable bases for identifying useful new compounds.

Although some authors have found higher rates of activity among plants with ethnomedical uses, expecting to identify novel therapeutic compounds from traditional medicinal plants is not necessarily realistic. Native traditional practitioners were, and continue to be, sophisticated in their ability to identify plants with biological activity, and to use them therapeutically. However, they did not use them in the context of Western medicine and Western disease concepts. The goals of native healers — finding plants that work for the medical problems of their communities — may not be identical to those of modern screening programs (finding novel compounds which can be used in Western medicine).

Finally, the issue of intellectual property needs to be considered. The plants we collected for this study fall into what Kloppenburg and Balick (1996) call the "middle ground" of intellectual property rights, that is plants "used regionally, by

more than one community or social group, and [having] different uses in different communities." We used secondary data gathered over a broad range of time and the entire Prairie Bioregion to target the plants for study. Nevertheless, we believe that Native people in the region should benefit if a new therapeutic agent were identified from a prairie plant that they traditionally used. We are looking for suggestions for how to do this. The use of royalties, an approach often called for by advocates of indigenous intellectual property rights, would be problematic in this case because for most tribes, commercialization of their knowledge is a violation of spiritual beliefs. Other ways to give something in return might be the establishment of a scholarship fund for Native American students at universities or other institutions, or funding medicinal plant gardens or ecological restoration on the Indian reservations in the region.

CONCLUSIONS

The Indian tribes of the Prairie Bioregion in North America used at least 203 species of medicinal plants (Kindscher 1992). These plants were not used against AIDS because native people did not encounter this disease historically. In addition, cancer was typically not identified by them as a specific disease. However, these plants were used for 78 different types of diseases and illnesses (Table 1). We believe that these uses suggest potentially active medicinal constituents and a broad knowledge base of plant use for health and in healing systems.

By collecting plants with a history of medicinal uses, we have increased our proportion of plants active in the NCI anti-HIV in-vitro screening assay. "Modified random" collection of plants world-wide (37,500 species) has lead to a 13.9% rate of activity for aqueous extracts and a 3.0% rate for organic extracts (Cardellina *et al.* 1993). Our data from 22 species has produced a significantly higher rate of activity of 60% for the aqueous extracts (12 of 20) and 13.6% for the organic extracts (3 out of 22). Although the higher percentage of activity does not mean that useful compounds will be found, it does show the promise that these plants potentially offer. Traditional knowledge of Native Americans should not only be studied (perhaps more appropriately stated as "learned"), but should be honored for the valuable insights it can offer, one of which is leads for finding plants that have active medicinal constituents. In addition, we believe that plants of native prairies and other ecosystems in our own continent merit further exploration and study.

ACKNOWLEDGEMENTS

For coordinating laboratory testing at the NCI and providing valuable comments on this manuscript, we are indebted to Mike Boyd, Laboratory of Drug Discovery Research and Development, National Cancer Institute. We greatly appreciated the help of Hillary Loring of the Kansas Biological Survey; Alexandra Fraser, Jeremy McClain, and Megan Mehaffey of the Department of Systematics and Ecology; and Lisa Kahn of the Department of Botany, University of Kansas, for their assistance with plant collection, voucher specimen preparation, data management, and editing. We received support for this project through the University of Northern Iowa from the Iowa Science Foundation and the Iowa Carver Foundation.

LITERATURE CITED

ANDROS, F. 1883. The medicine and surgery of the Winnebago and Dakota Indians. American Medical Association Journal 1:116-118.

BALICK, MICHAEL J. 1990. Ethnobotany and the identification of therapeutic agents from the rainforest. Pp. 22-30 *in*: Bioactive Compounds from Plants, Derek J. Chadwick and Joan Marsh (editors). Ciba Foundation Symposium 154. John Wiley and Sons, Chichester.

———. 1994. Ethnobotany, drug development and biodiversity conservation-exploring the linkages. Pp. 4-24 *in* Ethnobotany and the Search for New Drugs, Derek J. Chadwick and Joan Marsh (editors). Ciba Foundation Symposium 185. John Wiley and Sons, Chichester.

——— and ROBERT MENDELSOHN. 1992. Assessing the economic value of traditional medicines from tropical rain forests. Conservation Biology 6:128-130.

BLANKENSHIP, J. W. 1905. Native Economic Plants of Montana. Montana Agricultural Experiment Station, Bulletin no. 56.

BEUTLER, J. A., T. C. McKEE, R. W. FULLER, M. TISCHLER, J. H. CARDELLINA II, K. M. SNADER, T. G. MCCLOUD, and M. R. BOYD. 1993. Frequent occurrence of HIV-inhibitory sulphated polysaccharides in marine invertebrates. Antiviral Chemistry and Chemotherapy 4(3):167-172.

BOYD, M. R. 1989. Status of the NCI preclinical antitumor drug discovery screen: Implications for a selection of new agents for clinical trial. Pg. 1 *in* Cancer: Principles and Practice of Oncology Updates 3(10), V. T. Devita, Jr., S. Hellman, and S. A. Rosenberg (editors). Lippincott, Philadelphia, Pennsylvania.

BRAY, EDMUND C. and MARTHA COLEMAN BRAY (editors). 1976. Joseph N. Nicollet on the Plains and Prairies — the Expeditions of 1838-39 with Journals, Letters, and Notes on the Dakota Indians. Minnesota Historical Society Press, St. Paul.

BUECHEL, EUGENE. 1983. A Dictionary of Teton Sioux Lakota-English: English-Lakota. Red Cloud Indian School, Pine Ridge, South Dakota.

BUSHNELL, DAVID I., Jr. 1909. The Choctaw of Bayou Lacomb St. Tammany Parish, Louisiana. Smithsonian Institution, Bureau of American Ethnology, Bulletin 48. Washington, D.C.

CAMAZINE, SCOTT and ROBERT A. BYE. 1980. A study of the medical ethnobotany of the Zuni Indians of New Mexico. Journal of Ethnopharmacology 2:365-388.

CARDELLINA, JOHN H., MURRAY H. G. MUNRO, RICHARD H. FULLER, KIRK P. MANFREDI, TAWNYA C. MCKEE, MARK TISCHLER, HEIDI R. BOKESCH, KIRK R. GUSTAFSON, JOHN A. BEUTLER, and M. R. BOYD. 1993. A chemical screening prioritization strategy for the dereplication and prioritization of anti-HIV inhibitory aqueous natural products extracts. Journal of Natural Products 56:1123-1129.

CARLSON, GUSTAV G. and VOLNEY H. JONES. 1939. Some notes on uses of plants by the Comanche Indians. Michigan Academy of Science, Arts, and Letters 25: 517-542.

COX, PAUL ALAN. 1990. Ethnopharmacology and the search for new drugs. Pp. 40-55 *in* Bioactive Compounds from Plants, Derek J. Chadwick and Joan Marsh (editors). Ciba Foundation Symposium 154. John Wiley and Sons, Chichester, England.

———, L. REBECCA SPERRY, MERVI TUOMINEN, and LARS BOHLIN. 1989. Pharmacological activity of the Samoan ethnopharmacopoeia. Economic Botany 43(4):487-497.

CRAGG, GORDON M., MICHAEL R. BOYD, JOHN H. CARDELLINA, II, DAVID J. NEWMAN, KENNETH M. SNADER, and THOMAS G. McCLOUD. 1994. Ethnobotany and drug discovery: the experience of the National Cancer Institute. Pp. 178-196 *in:* Ethnobotany and the Search for New Drugs, Derek J. Chadwick and Joan Marsh (editors). Ciba Foundation Symposium 185. John Wiley and Sons, Chichester.

DENSMORE, FRANCES. 1974 (1928). How Indians Use Wild Plants for Food, Medicine, and Crafts (formerly, Uses of Plants by the Chippewa Indians). Dover Publications, New York.

DUNBAR, JOHN D. 1880. The Pawnee Indians. Magazine of American History 5(5):321-342.

FARNSWORTH, NORMAN R. 1990. The role of ethnopharmacology in drug development. Pp. 2-21 *in* Bioactive Compounds from Plants, Derek J. Chadwick and Joan Marsh (editors). Ciba Foundation Symposium 154. John Wiley and Sons, Chichester, England.

——— and DJAJA D. SOEJARTO. 1991. Global importance of medicinal plants. Pp. 25-51 *in* The Conservation of Medicinal Plants, Olayiwola Akerele, Vernon Heywood, and Hugh Synge (editors). Cambridge University Press, Cambridge.

FLETCHER, ALICE C. and FRANCIS LA FLESCHE. 1911. The Omaha Tribe. Smithsonian Institution Bureau of American Ethnology, 27th Annual Report. Washington. D.C.

GILMORE, MELVIN. 1913. A Study in the ethnobotany of the Omaha Indians. Nebraska State Historical Society 17:314-357.

———. 1914. Trip with White Eagle Determining Pawnee Sites. Unpublished Manuscript No.231, Nebraska State Historical Society Archives, Lincoln.

———. 1977 (1919). Uses of Plants by the Indians of the Missouri River Region. University of Nebraska Press, Lincoln. Reprint of a work first published as the 33rd Annual Report of the Bureau of American Ethnology (1919), Washington, D.C.

GREAT PLAINS FLORA ASSOCIATION. 1986. Flora of the Great Plains. University Press of Kansas, Lawrence.

GRINNELL, GEORGE BIRD. 1962. The Cheyenne Indians. 2 vols. Cooper Square Publishers, New York.

HART, JEFFREY A. 1976. Montana: Native Plants and Early Peoples. Montana Historical Society, Helena.

———. 1981. The ethnobotany of the Northern Cheyenne Indians of Montana. Journal of Ethnopharmacology 4:1-55.

HELLSON, JOHN C. 1974. Ethnobotany of the Blackfoot Indians. National Museum of Man, Mercury Series, Canadian Ethnology Service. Paper No. 19.

HODSON, T. J., F. ENGLANDER, and HSU O'KEEFE. 1995. Rain forest preservation, markets, and medicinal plants: Issues of property rights and present value. Conservation Biology 9:1319-1321.

HUNTER, JOHN D. 1957. Manners and Customs of Several Indian Tribes. Ross and Haines, Minneapolis.

JOHNSTON, ALEX. 1970. Blackfoot Indian utilization of the flora of the northwestern Great Plains. Economic Botany 24:301-324.

JORDAN, JULIA ANNE. 1965. Ethnobotany of the Kiowa-Apache. Master's Thesis, University of Oklahoma, Norman.

KARTESZ, JOHN. 1996. Revision: A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland. The Biota of North America Project of the North Carolina Botanical Garden.

KINDSCHER, KELLY. 1987. Edible Wild Plants of the Prairie: An Ethnobotanical Guide. University Press of Kansas, Lawrence.

———. 1992. Medicinal Wild Plants of the Prairie: An Ethnobotanical Guide. University Press of Kansas, Lawrence.

KLOPPENBURG, JACK R., JR. and MICHAEL J. BALICK. 1996. Property rights and genetic resources: A framework for analysis. Pp. 174-190 *in* Medicinal Resources of the Tropical Forest: Biodiversity and its Importance to Human Health, Michael J. Balick, Elaine Elisabetsky, and Sarah A. Laird (editors). Columbia University Press, New York.

KROEBER, A. L. 1908. The ethnology of the Gros Ventre. American Museum of Natural History, Anthropological Papers 1:145-281.

LEWIS, WALTER H. and MEMORY P. ELVIN-LEWIS. 1995. Medicinal plants as sources of new therapeutics. Annals of the Missouri Botanical Garden 82:16-24.

McCLINTOCK, WALTER. 1909. Materia medica of the Blackfeet. Zeitschrift fur Ethnologie 41:273-279.

———. 1923. Old Indian Trails. Houghton Mifflin Company, Boston.

McCUTCHEON, A. R., S. M. ELLIS, R. E. W. HANCOCK, and G. H. N. TOWERS. 1992. Antibiotic screening of medicinal plants of the British Columbian native peoples. Journal of Ethnopharmacology 37:213-223.

———. 1994. Antifungal screening of medicinal plants of the British Columbian native peoples. Journal of Ethnopharmacology 44:157-169.

MUNSON, PATRICK J. 1981. Contributions to Osage and Lakota ethnobotany. Plains Anthropology 26:229-240.

MURPHY, EDITH VAN ALLEN. 1959. Indian Uses of Native Plants. Mendocino County Historical Society, Ft. Bragg, California.

NICKERSON, GIFFORD S. 1966. Some data on Plains and Great Basin Indian uses of certain native plants. Tebiwa 9(1):45-47.

NOVELL, INC. 1994. Quattro Pro Software. Version 6.0.

ROGERS, DILWYN J. 1980. Lakota Names and Traditional Uses of Native Plants by Sicangu (Brule) People in the Rosebud Area, South Dakota. Rosebud Educational Society, St. Francis, South Dakota.

SHEMLUCK, MELVIN. 1982. Medicinal and other uses of the Compositae by Indians in the United States and Canada. Journal of Ethnopharmacology 5:303-358.

SMITH, HURON H. 1923. Ethnobotany of the Menomini Indians. Bulletin of the Public Museum of the City of Milwaukee 4(1):1-174.

———. 1928. Ethnobotany of the Meskwaki Indians. Bulletin of the Public Museum of the City of Milwaukee 4(2):175-326.

———. 1932. Ethnobotany of the Ojibwe Indians. Bulletin of the Public Museum of the City of Milwaukee 4(3):327-525.

———. 1933. Ethnobotany of the Forest Potawatomi Indians. Bulletin of the Public Museum of the City of Milwaukee 7(1):1-230.

SOKOL, ROBERT R. and F. JAMES ROHLF. 1995. Biometry — The Principles and Practice of Statistics in Biological Research. W.H. Freeman and Co., New York.

SPJUT, RICHARD. 1985. Limitations of a random screen: Search for new anticancer drugs in higher plants. Economic Botany 39(3):266-288.

——— and ROBERT E. PERDUE. 1976. Plant folklore: A tool for predicting sources of antitumor activity? Cancer Treatment Reports 60(8):979-985.

STEVENSON, MATILDA. 1915. Ethnobotany of the Zuni. Smithsonian Institution, Bureau of American Ethnology, 30th Annual Report. Washington, D.C.

TAN, G. T., J. M. PEZZUTO, A. D. KINGHORN, and S. H. HUGHES. 1991. Evaluation of natural products as inhibitors of human immunodeficiency virus type 1 (HIV-1) reverse transcriptase. Journal of Natural Products 54(1):143-154.

TYLER, VARRO E. 1993. The Honest Herbal — a Sensible Guide to the Use of Herbs and Related Remedies. Pharmaceutical Products Press, New York.

VESTAL, PAUL A. and RICHARD EVANS SCHULTES. 1939. The Economic Botany of the Kiowa Indians. Botanical Museum, Cambridge, Massachusetts.

VOGEL, VIRGIL J. 1970. American Indian Medicine. University of Oklahoma Press, Norman.

WAKEFIELD, E. G. and SAMUEL C. DELLINGER. 1936. Diet of Bluff Dwellers of the Ozark Mountains and its skeletal effect. Annals of Internal Medicine 9:1412-1418.

WEISLOW, O. S., R. KISER, D. L. FINE, J. BADER, R. H. SHOEMAKER, and M. R. BOYD. 1989. New soluble-formazan assay for HIV-1 cytopathic effect: Application to high-flux screening of synthetic and natural products for AIDS-antiviral activity. Journal of the National Cancer Institute 81:577-586.

YOUNGKEN, HEBER W. 1924. The drugs of the North American Indian (II). American Journal of Pharmacy 97:158-185, 257-271.

Urbock—Bier jenseits von Hopfen und Malz: Von den Zaubertränken der Götter zu den psychedelischen Bieren der Zukunft [Urbock—Beer Beyond Hops and Malt: From the Magic Potions of the Gods to the Psychedelic Beers of the Future]. Christian Rätsch. Aarau, Switzerland: AT Verlag, Bahnhofstrasse 39-43, CH-5001, 1996. Pp. 223. SF48.00/DM48.00/ÖS355.00 (clothbound with D/J); numerous color and B/W illustrations; glossary; two tables; three recipes; chronology; six pp. bibliography of 321 sources; three pp. index). ISBN 3-85502-553-3.

In my 1993 *Pharmacotheon* (Ott 1993:157), I remarked that, "An in-depth study of psychotropic additives to alcoholic beverages remains a *desideratum* of psychopharmacognosy," and now German anthropologist, well-known writer, and medicinal plant specialist Christian Rätsch has admirably addressed one major part of the task, publishing a detailed study of psychotropic additives to beers. His aptly-titled *Urbock—Beer Beyond Hops and Malt* is a beautifully-produced and lavishly-illustrated look at the history and botanical origins of beers, which almost immediately goes to the heart of the matter: "The Secret: The Additives," presenting a table listing 159 plant, five mineral, and nine animal additives, mostly psychoactive, to historical and actual beers of the world; including notations as to possible psychoactive principles, nature of presumed effects, and provenience. The bulk of the book consists of a 137-page section, "The Potions of the Gods," subdivided into 23 short chapters, commencing with specific examples of psychotropic-plant-enriched beers of antiquity, notably mandrake (*Mandragora* spp.) beer of the ancient Egyptians, and the *kykeon* of the archaic Greek Eleusinian Mysteries, thought to have been an aqueous infusion of ergot-infested (*Claviceps* spp.) barley containing psychotropic simple amides of lysergic acid; with speculations on the identity of the Aryan entheogen *soma*, a plant infusion extolled in the ancient *RgVeda* (Wasson 1968). I would say the *kykeon* and *soma* are here rather loosely classified as beers, as the latter did not even involve any grain substrate, and both were clearly prepared immediately prior to ceremonial ingestion, there being no time for fermentation or 'brewing', a hallmark of beers. There follows a fascinating survey of diverse beers or *chichas* of the world, with information on their preparation, source-grains and known or presumed additives. In every case, there are detailed examinations of all psychotropic plants involved, with superb illustrations, including color photographs and antique botanical illustrations, supporting summaries of our pertinent ecological, botanical, chemical, and ethnomedicinal knowledge. In the chapter, "The True 'Pilsener'," Rätsch shows convincingly that originally Pilsener beer was that brewed with *Bilsenkraut* or henbane, *Hyoscyamus niger* L. [still called *Pilsenkraut* in Switzerland], noting the specious nature of the common explanation of the name, alleging such beer came first from Slovakian Plzen [*Pilsen* in German]. Rätsch also makes a solid case for the identity of the notorious inebriant of the infamous Berserker warriors, as a beer infused with the ericaceous *Ledum palustre* L., still used as a shamanic inebriant in Siberia (Brekhman and Sam 1967). He summarizes the argument against the fanciful assumption that this drug was the more famous Siberian shamanic inebriant *Amanita muscaria* (L. ex Fr.) Persoon ex Gray, which ought to have been laid to rest 28 years ago by R. Gordon Wasson's pioneering study of this fabled mushroom (Wasson 1968). In

support of his theory that the Berserkers used *Ledum palustre* [German: *Sumpfporst*] beer, Rätsch proffers details of his psychonautic bioassay of garden-variety beer fortified with 20 drops of a homeopathic Ur-tincture of *L. palustre* — although he did not describe any wild Valkyrian riot and rapine, it is noteworthy that he "rapidly drained" a second glass! One cannot but admire such devotion to the demands of science! *Urbock* then proceeds to a review of the various contemporary beer festivals, showing their pagan, not Christian roots, and provides revealing details on the beer-brewing (and swilling) monks of the Middle Ages, concluding with reflections on the contemporary revival of hemp-beer (infused with *Cannabis* extracts) and suggestions for "Psychedelic Beers of the Future,"with actual recipes for mandrake, henbane, and hemp beers. Along the route of this cervisial ride of the Valkyries, Rätsch makes the perspicacious observation that the famous *Bayerisches Reinheitsgebot* (later *Deutsches Reinheitsgebot* —'German Purity Law) of 1516, which limited ingredients of beers to water, hops (*Humulus lupulus* L.), and barley-malt — frequently hailed as an enlightened consumer-protection law, ahead of its time — was in reality a prototypical drug-prohibition statute, as it effectively proscribed the use of innumerable traditional visionary, stimulating, and aphrodisiacal beer additives in favor of the soporific hops, thus converting beers into the rather stupefying libations we all know, combining alcohol with hops' 2-methyl-3-butene-2-ol. This Christian, anti-pagan law thus fits squarely into the millennial Pharmacratic Inquisition against shamanic inebriants (Ott 1995). The back-matter of *Urbock* consists of ten pages of footnotes to a bibliography of sources, followed by a sketchy, 2+ page index — given the wealth of recondite and interesting information the book contains, the reader deserves at least 11 pages of index, rather than merely 2 (5% of the text pages as index is a good rule-of-thumb for scientific books); at least there ought to have been a botanical-name index. This oversight may be due to the fact that the publisher intended the book more as a visual delight than a scholarly tome, although clearly the author, at pains to make text citations to a comprehensive bibliography, had a different conception. Not to split hairs, I must emphasize that as a visual feast, or illustrative "beer blast," *Urbock* succeeds on all counts and leaves no stone unturned. The author and publisher are to be commended for their diligence in assembling such a beautiful and comprehensive amalgam of artworks: innumerable beer labels; exquisite botanical woodcuts, drawings and paintings; color photographs of the source grains and additive plants; color photographs of the preparation (and enjoyment!) of traditional beers of many lands... even of a delightfully-ruddy, home-brewed *genuine* Pilsener [henbane] beer! The only thing wanting is a companion volume on psychotropic additives to wines, and of course some taste-test samples to accompany review copies of the book!

LITERATURE CITED

BREKHMAN, I. I. and Y. A. SAM. 1967. Ethnopharmacological investigation of some psychoactive drugs used by Siberian and far-eastern minor nationalities of U.S.S.R. Pg. 415 *in* Ethnopharmacologic Search for Psychoactive Drugs, D. H. Efron *et al.* (editors). U.S.P.H.S. Publication No. 1645. U.S. Government Printing Office, Washington, D.C.

OTT, JONATHAN. 1993. Pharmacotheon: Entheogenic Drugs, Their Plant Sources and History. Natural Products Co., Kennewick, Washington. Spanish translation, 1996. Los Libros de la Liebre de Marzo, Barcelona, Catalunya, Spain.

OTT, JONATHAN. 1995. The Age of Entheogens and The Angels' Dictionary. Natural Products Co., Kennewick. Washington.

WASSON, R. GORDON. 1968. *Soma*: Divine Mushroom of Immortality. Mouton, The Hague, The Netherlands.

Jonathan Ott, President
Natural Products Co.
Apartado Postal 532
Xalapa, Veracruz, México

Journal of Ethnobiology 18(2):249-269 Winter 1998

THE ROOTS OF TRADITION: SOCIAL ECOLOGY, CULTURAL GEOGRAPHY, AND MEDICINAL PLANT KNOWLEDGE IN THE OZARK-OUACHITA HIGHLANDS

JUSTIN M. NOLAN
Department of Anthropology
107 Swallow Hall
University of Missouri
Columbia, MO 65211

ABSTRACT. — This paper examines the ecological and cultural factors effecting medicinal plant use and knowledge in the Ozark-Ouachita Highlands of Missouri and Arkansas. Information on useful species was collected from 14 local experts in the Ozark and Ouachita Mountains, each from different communities evenly distributed between the two regions. Forest composition data were examined using the index of similarity in order to establish an overview of each region's distinct ecological characteristics. Despite the observed ecological differences, similar patterns of medicinal plant use emerge between the two regions, which is attributed to the persistence of shared traditions of plant use in the Highlands. Other informant-specific factors, such as length of experience with medicinal plants, and community-specific factors, such as geographic proximity to cosmopolitan centers, are also responsible for the observed variation in medicinal plant knowledge. It is suggested that the guardianship of medicinal plant knowledge and praxis in the Ozark-Ouachita Highlands—and elsewhere in the rural US—ultimately depends upon the interdependent processes of cultural and ecological conservation.

RESUMEN. — Este trabajo examina los factores ecológicos y culturales que afectan el uso y conocimiento de las plantas medicinales en la zona alta Ozark-Ouachita de Missouri y Arkansas, Estados Unidos de Norteamérica. Se colectó información acecra de especies útiles consultando a 14 especialistas locales en las montañas Ozark y Ouachita, cada uno de ellos de comunidades diferentes distribuídas uniformemente entre las dos regiones. Se examinaron datos acerca de la composición de los bosques empleando el índice de similitud para establecer un panorama general de las características ecológicas distintivas de cada región. A pesar de las diferencias ecológicas observadas, emergen patrones similares de uso de plantas medicinales entre las dos regiones, lo cual es atribuido a la persistencia de tradiciones compartidas de uso de plantas en la zona alta. Otros factores específicos a los informantes, tales como la duración de la experiencia con plantas medicinales, y factores específicos a las comunidades, tales como la proximidad geográfica a centros cosmopolitas, son también responsables de la variación observada en el conocimiento de las planta medicinales. Se sugiere que el resguardo del conocimiento de las plantas medicinales y su práctica en la zona alta Ozark-Ouachita — y en otras áreas rurales de los Estados Unidos — depende ultimadamente de los procesos interdependientes de conservación cultural y ecológica.

RÉSUMÉ. — Dans cet article, nous examinons les facteurs écologiques et culturels qui influencent l'utilisation et la connaissance des plantes médicinales dans les Hautes-Terres des Monts Ozark et Ouachita dans le Missouri et l'Arkansas. Des

données sur les espèces utiles ont été rassemblées auprès de 14 experts locaux des Monts Ozark et Ouachita, les informateurs provenant de communautés différentes également réparties dans les deux régions. Les données relatives à la composition des forêts ont été analysées en fonction d'un indice de similarité afin d'établir un portrait général des caractéristiques écologiques propres à chaque région. Malgré les différences écologiques observées, les deux régions montrent des modèles similaires d'utilisation des plantes médicinales, ce qui peut être attribué à la persistance des traditions communes d'utilisation des plantes dans les Hautes-Terres. D'autres facteurs spécifiques aux informateurs, tels que l'expérience des plantes médicinales, ainsi que des facteurs spécifiques aux communautés, tels que la proximité géographique de centres cosmopolites, peuvent aussi expliquer les variations observées dans la connaissance des plantes médicinales. Nous proposons que la protection des pratiques et des connaissances relatives aux plantes médicinales dans les Hautes-Terres des Monts Ozark et Ouachita et ailleurs, dans les milieux ruraux américains, dépend en fin de compte de processus interdépendants de conservation culturelle et écologique.

Ethnobotanical research has traditionally focused on the collection and documentation of cultural information on useful plants. In recent years, however, ethnobotanists have begun to explore the various factors that influence and sustain indigenous plant knowledge. That is, *how* do people engage in plant selection, and *why* do people know about the plants they do? To a certain extent, diversity and availability play a role in shaping ethnobotanical knowledge; human cultures are most cognizant of ambient plant species that are ecologically accessible (Brush 1996; Turner 1988). However, the abundance of a given species in nature does not necessarily ensure its use (Moerman 1979, 1989). As Nina Etkin has suggested, the construction of local pharmacopoeias occurs through carefully calculated plant selection, or "ascriptions of efficacy" (1988:28).

This paper examines the ecological, cultural, and socioeconomic factors that effect medicinal plant use in the Ozark and Ouachita Mountains of the Southern US. Natives of these mountains belong to the same Upper South cultural heritage, yet the two zones are quite distinct in terms of physiography and biogeography. For this reason, the Ozark-Ouachita Highlands provide a unique ethnographic location in which to research how medicinal plant knowledge among experts is effected by forest composition and regional plant availability.

Traditional ethnobotanical knowledge among European-Americans, including the native residents of the Ozark-Ouachita Highlands, is a relatively unexplored area of study. One of the goals of this paper is to describe the cultural and geographic continuity of medicinal plant use, a folk tradition that connects the Ozark-Ouachita region and to its cultural sources of Southern Appalachia and the British Isles. Because folk botanical knowledge is effected by more than ecology and tradition, this paper also examines a number of socioeconomic and demographic variables thought to be associated with its preservation.

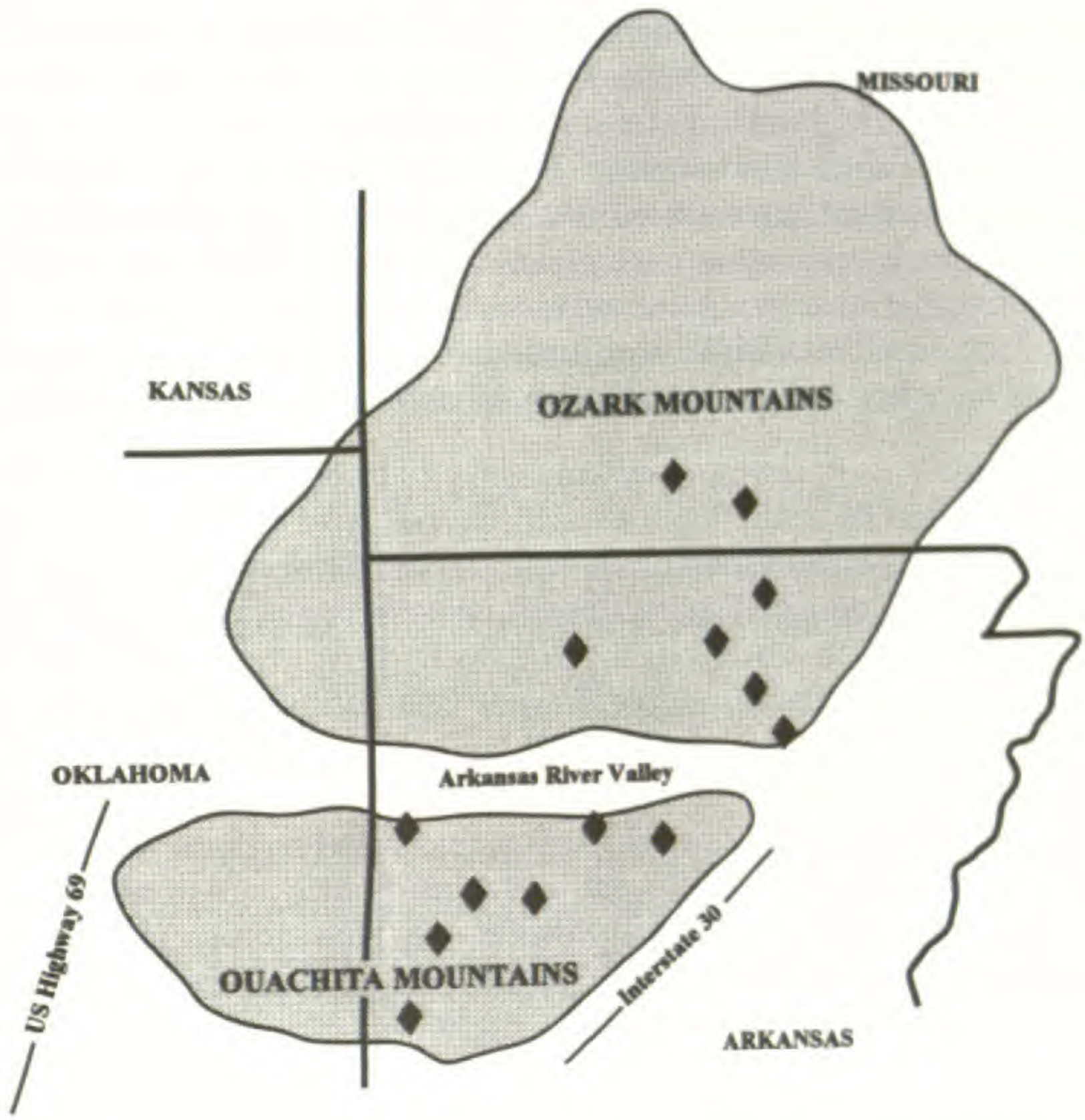


FIGURE 1. — Map of the Ozark-Ouachita study area (Markers represent location of communities visited.)

DESCRIPTION OF THE STUDY REGION

The Ozark and Ouachita Mountains comprise a remote, densely wooded region of America's heartland. Collectively known as the Interior Highlands of the United States, the combined area encompasses around 70,000 m^2 in four Midwestern states (Fig.1). Extending across 93 counties in Missouri, Arkansas, Oklahoma, and Kansas, the Ozarks cover nearly 50,000 m^2 (Rafferty 1980); the Ouachitas subsume around 20,000 m^2 across 37 counties within the states of Arkansas and Oklahoma (Rafferty and Catau 1991).

Physiographic features. — The Ozarks are a rugged region of hills and low mountains with elevations ranging from 250 to 2400 feet above sea level. Formed during the Early Paleozoic, the Ozarks are comprised of repetitive sedimentary rocks dissected into high hills and deep valleys through the process of watershed erosion (Unklesbay and Vineyard 1992). Mixed upland forest dominates the region's flora, which is rich and diverse due to the fertile limestone soils (Hunter 1989). A blend of oaks, hickories, maples, and shortleaf pines cover the Ozark hillsides, with the oak-hickory forest type predominating. The region's bottomland habitats are characterized by sweet-gum, sycamore, and river birch forest types (Ware *et al.* 1992; Hines 1988a).

In the Ouachita Mountains to the south, elevations range from 400 to 2800 feet at the highest peaks. Geologically much younger than the Ozarks, the Ouachitas were formed during the Late Paleozoic when the native bedrock underwent intensive structural folding and warping (Rafferty and Catau 1991; Hunter 1989). Characterized by long, parallel ridges running east to west, the Ouachitas are covered with thin, acidic soils which are generally less fertile that the Ozarks and consequently support fewer types and numbers of wild plant species (Hunter 1989). Vast stands of shortleaf and loblolly pine forests dominate the region's forests (Hines 1988b), which have been subjected to many decades of heavy timber extraction.

Cultural characteristics. — The cultural landscape of both the Ozark and Ouachita Mountains is colored by rural ways of life, marked by a retention of traditional Upper South customs and a resistance to change and modern technology (McNeil 1995; Rafferty and Catau 1991). Most natives of both Highland regions are white Protestants of Scotch-Irish descent (Gerlach 1986; Rafferty and Catau 1991; Rossiter 1992), described as resourceful people (Parker 1992) with a strong sense of identity (Randolph 1947), history (Rossiter 1992), and place (Rafferty 1987). Before the Civil War era, the dominant form of settlement adaptation in the region had been rural agriculturalism. The frontier migrants who settled both the Ozarks and the Ouachitas were European-American farmers from Southern Appalachia, specifically eastern Tennessee and Kentucky (Hensley 1987; Randolph and Wilson 1953). Not long after settling the region, the hill dwellers were branded with "hillbilly" stereotypes by virtue of their relative socioeconomic isolation (Sabo *et al.* 1990), a popular image still romanticized in American literature and film. However, like their Appalachian forebears, the contemporary hill people of the Ozarks and the Ouachitas remain somewhat separated from cosmopolitan cultural influences, which has fostered certain sociocultural traits including self-sufficiency, economic resourcefulness, and a distinctive regional dialect[1].

In a descriptive account of changing lifeways in the Ozark and Ouachita Highlands, Milton Rafferty identifies the salient characteristics of the Ozark-Ouachita cultural model, which include

> "clinging to the traditional technologies, a disdain for city life and education, a suspicion of outsiders, conservative politics...a reverence for outdoor activities...fundamental religious beliefs, with the persistence of traditional religious practices such as brush-arbor revivals and river baptisms...[and] a preference for traditional forms of entertainment and music" (Rafferty 1987:7).

Sadly, however, folk culture is vanishing in the Ozarks and the Ouachitas. Natives have begun to abandon traditional lifeways in favor of mainstream technology, modern services, and a more "progressive" worldview. The Highland economy has diversified from subsistence farming to include the large scale cultivation of corn, cotton, and livestock, along with the industries of lead mining, lumbering, tourism, and recreation (Rafferty 1980; Rafferty and Catau 1991). Economic growth and improved education have had mixed effects within the Ozarks and Ouachitas, bringing progress and money to the region yet causing the gradual dissimilation of vernacular culture.

Nonetheless, some Highland natives are resolute about maintaining deliberately independent and simple lifestyles, especially in the more remote mountain communities. In these isolated places, people continue to practice a number of time-honored cultural traditions. One of these is the custom of using wild plants for medicinal purposes. Much like the folk medicine of Southern Appalachia, medicinal plant use in the Ozarks and Ouachitas involves the direct procurement of wild plants and roots from the woods and using them to create a variety of medicinal extracts and decoctions (e.g., Gibbens 1992). It is deep in the forests where locals believe the most powerful medicines can be found.

RESEARCH METHOD AND DESIGN

Forest composition analysis. — In order to establish the different ecological character of the Ozarks and Ouachitas, forestry data were compiled and examined prior to conducting the ethnographic work. Statistical analysis was performed using raw forestry data supplied by the US Department of Agriculture. These documents provided detailed counts of trees based on grid sample estimates for forest survey locations covering 3,840 acres in the Ouachitas and 3,840 acres in the Ozarks (Foti and Devall 1994; Hines 1988a, 1988b). From these raw data, an index of similarity was calculated as a means of identifying differences in species abundance, variety and dominance that characterize the flora of the Ozarks and Ouachitas. In addition, the herbaceous and woody species associated with the dominant forest types of each region were compiled to establish the general differences in plant availability between the two zones.

Selection and interviewing the informants. — Fourteen communities across the Ozarks and Ouachitas were visited during the summers of 1995 and 1996. Communities are evenly distributed between the two regions. These locales, situated within counties classified as "Ozark" or "Ouachita" by Rafferty (1980) and Rafferty and Catau (1991), were chosen on the basis of relative geographic isolation from major cities and interstate highways. Twelve of the communities are located in western and northern Arkansas; two lie in southern Missouri.

One key informant in each community was selected according to local reputation[2] (Martin 1995). Nine of the 14 informants are elderly females, known locally as *granny women*, who offer plant-based therapy to all comers, usually free of charge. Granny women gather plants directly from the woods and roadsides near their homes, although some will travel short distances to obtain the plants that do not grow close by. After collecting the plants they need, the granny-women will either prepare them into hot infusions for internal use by steeping the plants in boiling water, or prepare poultices for external application by drying the plants outdoors and later crushing the leaves and mixing them with substances such as lard or vegetable oil.

The other five informants are males of mixed ages. Three call themselves *yarb doctors*, a colloquial term for male practitioners who specialize in combining wild botanicals with a number of household items such as liquor, honey, turpentine, milk, oil, vinegar, and salt. Like the granny-women, yarb doctors readily offer their expertise to any community member in need. The remaining two informants

are expert *root-diggers* who earn a living by collecting the medicinal roots of young trees and shrubs and selling them to wholesale drug buyers or local store owners. Each of the 14 informants gather their own plants rather than cultivating them or purchasing them from outside sources.

Unlike larger ethnobotanical surveys that document knowledge variation on a regional or community level (e.g., Benz *et al.* 1994), only local plant *specialists* were consulted during this project. Non-experts ("lay" plant users), whose knowledge is potentially different from that of the plant experts, were not interviewed. Hence, this study addresses the esoteric (specialized) knowledge of medicinal plants versus the *exoteric* (common) knowledge of the broader community.

During semistructured interviews, all informants completed a free list task (Bernard 1994; Robbins and Nolan 1997) designed to elicit the common names of culturally significant medicinal plants. Free listing, an effective survey tool for ethnobotanists (Martin 1995), was the primary mode of inquiry into the nature of medicinal plant use. Once the informant had completed the free list task, she or he was asked to list all of the ways that each listed plant could be used to treat illnesses[3]. The informant was also asked to indicate which part of the plant is used and how it is prepared for use by the patient. Finally, informants were asked to describe the attributes of each listed plant (leaf shape, flowering time, etc.) to aid in the formal identification of reported species. Ethnobotanical data collection resulted in (1) an exhaustive list of medicinal plant names, (2) the corresponding applications, (3) the name of the useful plant part, (4) the method of preparation, and (5) a physical description. Additional ethnographic information, including informant age, length of residence in community, and length of experience in curing or plant procurement was also collected during interview sessions.

Data analysis. — Each reported plant was identified to species level by consulting floral keys (Hunter 1984, 1989; Moore 1988; Denison 1991) and by cross-checking the published species descriptions against those supplied by the informants. The natural habitats for each reported species were documented in order to determine the relationship between ecological presence and local knowledge of plants. The distribution of plant reports was analyzed and compared to inventories of locally available understory species in each zone to further assess the association between vernacular plant knowledge and availability. In addition, a number of relevant sociodemographic variables pertaining to the informants and their home communities were examined to identify how regional geography and economy effect medicinal plant use and knowledge throughout the study area.

REGIONAL FOREST COMPOSITION

Index of similarity. — In order to assess the ecological characteristics of each region, the index of percent similarity (S) was used. The index of similarity offers a good way to assess regional differences in floral assemblages between two forest communities. By taking into account both richness (the number of species represented) and evenness (the abundance of individuals within species) the index of similarity integrates two of the three principal components of diversity[4]. For each species present in the sample, a proportion is calculated by dividing the number of indi-

viduals by the sum total of individuals in the inventory. Accordingly, S is calculated as follows:

$$S = 1 - \tfrac{1}{2}\Sigma \mid P_a - P_b \mid$$

where P_a is the proportion of each species inventoried in the Ozark forests and P_b the proportion of each tree species documented in the Ouachita forests. The index generates a value ranging between 0 and 1, where 1 indicates perfect similarity and 0 indicates perfect dissimilarity between two forest communities.

A similarity index of 0.787 was computed for the two forests (see Table 1 for calculations of percent presence for all species present in both samples). Although this value does not suggest a dramatic difference between the two forest regions, the index reveals two clear points. First, the Ozarks are richer in species than the Ouachitas, and similarly show a higher level of evenness. Secondly, there is a notable contrast in species composition that differentiates the two regions. To illustrate: the Ozarks contain high percentages of hickory (15.44%) and other hardwoods (22.28%), with a low percentage of pine varieties (7.06%). In the Ouachitas, shortleaf and loblolly pine dominate by an enormous margin (24.84%), while hickory

TABLE 1. — Calculation of index of similarity for Ozark and Ouachita forests.

	Ozarks		Ouachitas		
Species	Number*	% (P_a)	Number*	% (P_b)	$\mid P_a - P_b \mid$
Shortleaf-loblolly pine	256943	7.064	513678	24.842	17.778
Cypress	1512	0.042	898	0.043	0.001
Other softwoods	255568	7.026	53316	2.578	4.448
Select white oaks	324041	8.908	157858	7.634	1.274
Select red oaks	104386	2.869	56764	2.745	0.142
Other white oaks	274144	7.537	157724	7.268	0.269
Other red oaks	281990	7.753	100568	4.864	2.889
Hickory	561743	15.443	241913	11.699	3.744
Hard maple	61497	1.691	5572	0.269	1.422
Soft maple	119916	3.296	63914	3.091	0.205
Beech	10776	0.296	9	0	0.296
Sweet gum	65131	1.791	96100	4.648	2.857
Tupelo-blackgum	147054	4.043	81981	3.965	0.078
Ash	61918	1.702	30569	1.478	0.224
Cottonwood-aspen	42	0.001	20	0.001	0
Basswood	3840	0.106	3276	0.158	0.052
Yellow poplar	46	0.001	0	0	0.001
Black walnut	8633	0.237	0	0	0.001
Other hardwoods	810322	22.278	317318	15.346	6.932
Noncommercial	287884	7.915	186262	9.008	1.093
Σ(all species)	3637386		2067742		

$\Sigma \mid P_a - P_b \mid$

Index of similarity $[S = 1 - \tfrac{1}{2}\Sigma \mid P_a - P_b \mid] = 0.79$

*per 3,840 acres of forested land in each region

Sources: Foti and Devall 1994; Hines 1988a, 1988b

and other hardwoods are relatively less abundant (11.70% and 15.34%, respectively). Nearly all of the Ozarks' hardwood proportions exceed those found in the Ouachitas, a reflection of the high percentage of softwood in the Ouachita mountain forests. At the outset, the index of similarity reflects only a moderate difference between the two regions' proportions of tree assemblages. Yet the species counts reveal that the Ozark forests contain several species not found in the Ouachitas, such as beech, tupelos, magnolias, yellow-poplars, and a variety of locusts and elms (Hinds 1988a, 1988b). Ecologists have determined that the Ozarks are home to a greater number of forest types, such as the oak savanna and the cedar glade communities, which appear abundantly throughout the Missouri Ozarks and less frequently across the Ouachitas (Vogele 1990).

Unfortunately, systematic forest surveys such as those employed in this study do not inventory the understory plants growing in an area; therefore, it is impossible to calculate a complete species-by-species percent similarity index that compares all aspects of plant growth between the Ozarks and Ouachitas. However, certain important inferences about the overall nature of plant availability can be drawn from the data. Biologists report that the herbaceous layer of forests

TABLE 2. — Commonly occurring herbaceous and woody plants in dominant forests of the Ozark and Ouachita Mountains.

Region and Forest Type	*Herbaceous Plants*	*Woody Plants*
Ozarks	Violet	Woodbine
(Oak-hickory and Mixed	Tick trefoil	Grape
Hardwood Dominant)	Bedstraw	Coralberry
	Snakeroot	Bluebeech
	Aster	Hickory
	Sorrel	Greenbrier
	Skullcap	Redbud
	Bidens	Red elm
	Mint	Dogwood
	Ironweed	Paw paw
	Black cohosh	Witch Hazel
	Hound's tongue	Maple
	Jewelweed	Ironwood
	Ginseng	
	Golden Seal	
Ouachitas	Lespedeza	Blueberry
(Pine Dominant)	Tick trefoil	Hickory
	Aster	Sassafras
	Pussy's toes	Black oak
	Cinquefoil	White oak
	Goat's rue	Post oak
	Dittany	Grape
	Spurge	Brambles
	Sunflower	Woodbine
	Mint	Goldenrod

Sources: Hunter 1984, 1989; Murphy and Crawford 1970; Murphy and Ehrenreich 1965; Read 1951.

is structurally dependent on the nature of the forest itself (Falinska 1985). To illustrate, factors such as overstory crown cover, which is greater in hardwood forests than pine forests (Murphy and Crawford 1970), are known to effect the growth patterns of understory species (Ehrenreich and Crosby 1960). Table 2 lists the most abundant herbaceous and woody plant species associated with the oak-hickory forests of the Ozarks and the pine forests which dominate the Ouachitas. As shown in Table 2, the two regions provide a natural habitat for quite different assemblages of understory species and woody taxa. In general, the forest habitat of the Ozarks is suitable for a greater number and diversity of shade tolerant plants, given the higher percentage of crown closure that characterizes the locally dominant oak-hickory woodlands. Deciduous forests of this variety are thought to be optimal sources for medicinal plant procurement because the herbaceous layer of understory growth is characteristically lush and more continuous than other forest types (Price 1998; Raitz and Ulack 1984). Although there is some overlap between the kinds of plants associated with each of the two study zones, the pine woodlands of the Ouachitas provide fewer kinds and numbers of trees and herbs than the Ozark forests (e.g., Hunter 1989).

The natural landscape of these Highlands offers an interesting distinction in terms of regional plant geography. The differences in growth patterns of understory and woody plants could potentially effect the cultural use and knowledge of wild medicinal species by local experts. However, despite this observed ecological contrast, the following discussion will show that similar patterns of medicinal plant selection and use are found among experts between the two regions.

RESULTS AND DISCUSSION

Thirty-nine medicinal plant names were collected from the 14 informants. The length of each informant's list of plants varied from 4 to 15 plant names, with a median of 9.5. A total of 129 reports were made. Informants reported a mean of 9.21 plants, with a standard deviation of 3.19 and a coefficient of relative variation (CRV) of .346. A total of 224 different plant applications were recorded (see Appendix for applications of reported plants). The number of applications reported varied from 6 to 26, with a median of 16. The average number of applications per informant was 16, with a standard deviation of 6.71 and a CRV of .419.

The distribution of medicinal plant reports. — Ozark informants reported a higher number of medicinal plants on average (11.29 per informant) than those of the Ouachitas (7.14 per informant). Of the 129 reports of medicinal plant names collected from all informants, 61% of the reports were supplied by Ozark informants, while the Ouachita informants provided 39% of the total. The distribution of reported plant applications closely parallels the distribution of reported plant names, with 59% of the 224 applications given by Ozark informants and 41% supplied by Ouachita informants.

Table 3 lists all of the medicinal plants reported by informants in alphabetical order with both scientific and vernacular names. Listed alongside each species are the number and percentage of informants reporting the plant. Corresponding percentages were calculated by dividing each number of reports by 14, the total number

TABLE 3. — Frequency of mention for reported medicinal plants.

Species	Vernacular Name	Family	Number of Informants	Percent of Informants Reporting
Impatiens capensis L.	Jewelweed	Balsaminaceae	11	79%
Podophyllum peltatum L.	May Apple	Berberidaceae	8	57%
Sassafras albidum Nees	Sassafras	Lauraceae	8	57%
Eryngium yuccafolium L.	Snakeroot	Apiaceae	7	50%
Prunus serotina L.	Black Cherry	Rosaceae	7	50%
Rhus aromatica L.	Sumac	Anacardiaceae	6	43%
Juniperus virginiana L.	Juniper	Cupressaceae	6	43%
Prunella vulgaris L.	Heal-All	Lamiaceae	6	43%
Phytolacca americana L.	Pokeweed	Phytolaccaceae	6	43%
Zanthoxylum americanum L.	Toothache Tree	Rutaceae	6	43%
Juglans nigra L.	Black Walnut	Juglandaceae	5	36%
Magnolia tripetala L.	Magnolia	Magnoliaceae	5	36%
Rubus spp.	Blackberry	Rosaceae	5	36%
Panax quinquefolius L.	Ginseng	Araliaceae	4	29%
Tilia americana L.	Basswood	Tiliaceae	4	29%
Betula nigra L.	River Birch	Betulaceae	3	21%
Hamamelis virginiana L.	Witch Hazel	Hamamelidaceae	3	21%
Monarda spp.	Mint, Horsemint	Lamiaceae	3	21%
Hydrastis canadensis L.	Golden Seal	Ranunculaceae	3	21%
Carya texana Nutt.	Hickory	Juglandaceae	3	14%
Myrica cerifera L.	Wax Myrtle	Myricaceae	2	14%
Ulmus rubra L.	Slippery Elm	Ulmaceae	2	14%
Arisaema atrorubens Mart.	Indian turnip	Araceae	1	7%
Asclepias sp.	Milkweed	Asclepiadaceae	1	7%
Solidago sp.	Goldenrod	Asteraceae	1	7%
Alnus serrulata Mill.	Alder	Betulceae	1	7%
Lithospermum incisum L.	Yellow Puccoon	Boraginaceae	1	7%
Lobelia sp.	Lobelia	Campanulaceae	1	7%
Cornus sp.	Dogwood	Cornaceae	1	7%
Castanea pumila Mill.	Chinquapin	Fagaceae	1	7%
Geranium sp.	Crane's Bill	Geraniaceae	1	7%
Liquidambar styracifula L.	Sweet Gum	Hamamelidaceae	1	7%
Allium stellatum L.	Wild Onion	Liliaceae	1	7%
Morus rubra L.	Mulberry	Moraceae	1	7%
Fraxinus quadrangulata L.	Blue Ash	Oleaceae	1	7%
Passiflora incarnata L.	Passion Flower	Passifloraceae	1	7%
Rhamnus caroliniana L.	Buckthorn	Rhamnaceae	1	7%
Populus alba L.	Poplar	Salicaceae	1	7%
Salix sp.	Willow	Salicaceae	1	7%

TABLE 4. — Regional distribution of medicinal plant reports.

		Number of Informants Reporting	
Species	Vernacular Name	Ozarks	Ouachitas
Impatiens capensis L.	Jewelweed	7	4
Podophyllum peltatum L.	May Apple	5	3
Sassafras albidum Nees	Sassafras	3	5
Eryngium yuccafolium L.	Snakeroot	5	2
Prunus serotina L.	Black Cherry	4	3
Rhus aromatica L.	Sumac	2	4
Juniperus virginiana L.	Juniper	5	1
Prunella vulgaris L.	Heal-All	4	2
Phytolacca americana L.	Pokeweed	4	2
Zanthoxylum americanum L.	Toothache Tree	2	4
Juglans nigra L.	Black Walnut	2	3
Magnolia tripetala L.	Magnolia	3	2
Rubus spp.	Blackberry	3	2
Panax quinquefolius L.	Ginseng	4	0
Tilia americana L.	Basswood	2	2
Betula nigra L.	River Birch	1	2
Hamamelis virginiana L.	Witch Hazel	2	1
Monarda spp.	Mint, Horsemint	1	2
Hydrastis canadensis L.	Golden Seal	3	0
Carya texana Nutt.	Hickory	2	0
Myrica cerifera L.	Wax Myrtle	2	0
Ulmus rubra L.	Slippery Elm	1	1
Arisaema atrorubens Mart.	Indian turnip	0	1
Asclepias sp.	Milkweed	1	0
Solidago sp.	Goldenrod	0	1
Alnus serrulata Mill.	Alder	1	0
Lithospermum incisum L.	Yellow Puccoon	1	0
Lobelia sp.	Lobelia	0	1
Cornus sp.	Dogwood	1	0
Castanea pumila Mill.	Chinquapin	1	0
Geranium sp.	Crane's Bill	0	1
Liquidambar styracifula L.	Sweet Gum	1	0
Allium stellatum L.	Wild Onion	0	1
Morus rubra L.	Mulberry	1	0
Fraxinus quadrangulata L.	Blue Ash	1	0
Passiflora incarnata L.	Passion Flower	1	0
Rhamnus caroliniana L.	Buckthorn	1	0
Populus alba L.	Poplar	1	0
Salix sp.	Willow	1	0
Total Number of Reports Per Region		79	50
Mean Number of Reports Per Informant		11.3	7.1

Correlation Coefficient = .48, $p < .01$.

of informants in the sample. The regional distribution of medicinal plant reports is given in Table 4, which lists the plants according to the number and location of informants reporting use. For the 22 plants listed by more than one informant, the number of reports are divided rather evenly between the two informant groups. Only two of these plants, golden seal (*Hydrastis canadensis*) and ginseng (*Panax quinquefolius*), were reported exclusively in the region to which they are ecologically restricted — the Ozarks. All of the remaining medicinal plants listed by informants generally occur in wide distribution across both regions (Denison 1991; Hunter 1984, 1989). A rank order correlation analysis was performed on the plant reports to measure the degree of informant agreement on medicinal plant use. A highly significant correlation coefficient was found ($r_s = .48$, $p < .01$), which suggests that informants from both areas are essentially familiar with the medicinal properties of the same constellation of plants. The high level of informant agreement regarding these species' usefulness is probably the result of cultural assimilation of medicinal plant knowledge and the persistence of shared traditions of plant use.

Shared traditions of medicinal plant use. — A number plants commonly mentioned by informants can be traced historically to the pharmacopoeia of Southern Appalachia and beyond to the traditional plant lore of the British Isles. Sassafras (*Sassafras albidum*), one of the most commonly mentioned plants in both the Ozarks and the Ouachitas, has had widespread use as a hematic, or blood-building, herb by the frontier settlers of Appalachia, who learned much about healing plants from the native Cherokee Indians (Williams 1995). Informants in the Ozark and Ouachita Highlands similarly referred to the plant as a good treatment for purifying the blood and for reducing fever and body pain. The root of the young tree is still known to bring an appreciable price on the crude drug commercial market (Price 1998). The bark of wild black cherry (*Prunus serotina*) was frequently mentioned by Ozark and Ouachita experts for treating coughs and colds. The medicinal use of wild black cherry bark can also be traced to Southern Appalachia, where it has been widely used by folk healers as the chief component of cough syrups and cold remedies (Price 1998; Williams 1995). The less abundant ginseng and golden seal, which share similar habitats of undisturbed forests, have also been gathered extensively by the root-diggers and traditional healers of Appalachia (Price 1998). Ginseng was traditionally used by the Cherokee Indians for headaches and muscle cramps, while the Europeans of Appalachia and the Ozarks have adopted its use as a cure for fatigue and general malaise. Golden seal has been used in Appalachia to combat stomach pain and venereal diseases. In the Ozarks, the plant is similarly reported as a treatment for stomach pain, but it is also reported as a cleansing agent for infections and blood impurities. Several other plants reported by experts from both regions have been used in the same way by traditional Appalachian practitioners, including may apple (*Podophyllum peltatum*), slippery elm (*Ulmus rubra*), snakeroot (*Eryngium yuccafolium*), river birch (*Betula nigra*), pokeweed (*Phytolacca americana*), and toothache tree (*Zanthoxylum americanum*) (Allen 1995; Williams 1995; Price 1998).

Interestingly, a number of other reported species were important in the traditional medical culture of the British Isles. Blackberry (*Rubus* sp.) was highly

regarded in Scotland as a treatment for burns, gout, rheumatism; it was also coveted for its reputed power to protect the soul against evil spirits (Freethy 1985). Its folk use survives today in the Ozarks and Ouachitas, but only as a treatment for cold and flu symptoms. Heal-all (*Prunella vulgaris*), also known as woundwort, is native to Britain and Europe, and its use as a panacea for mouth ulcers in the Ozarks and Ouachitas was well known in the folk medicine of Britain and Ireland (Freethy 1985). Relatives of the Anglo-American black walnut, reported in this study as useful for stopping diarrhea and treating ringworm, have been used for many generations by folk medical experts in Great Britain (Rudd 1990). Slippery elm, ash, and juniper also appear in the native pharmacopoeias of Scotland and Ireland (Freethy 1985; Rudd 1990). Not surprisingly, the original applications for some of these plants have changed across time and space. Yet the contemporary inhabitants of the Ozarks and Ouachitas maintain a number of the same uses known by the Appalachian mountaineers and their Scotch-Irish predecessors. The cultural continuity of these shared traditions of plant use may account for the response pattern observed in the free-list task.

Knowledge variation. — While similar plant use patterns are evident among informants, considerable variation exists regarding the practitioners' knowledge of medicinal plants. Table 5 presents data on geographic and socioeconomic variables for the 14 informants and their respective home communities, including region (Ozark or Ouachita), distance from the nearest urban center of 50,000, informant age, sex, length of residence in community, and number of years of experience with plants as a folk practice. The number of plants and applications mentioned

TABLE 5. — Sociodemographic data for communities and informants.

Community Data			Informant Data			Medicinal Plant Data	
Informant/ Community	Region	Miles from Urban	Age and Sex	Length of Residence in Community	Length of Folk Practice	Number of Plants Reported	Number of Apps. Reported
1	Ouachita	56	76/ F	9	9	6	11
2	Ouachita	66	61/ F	50	15	4	6
3	Ouachita	52	65/ M	15	5	6	9
4	Ouachita	64	86/ F	60	10	7	8
5	Ouachita	89	77/ F	20	20	9	19
6	Ouachita	86	70/ M	45	20	8	16
7	Ouachita	81	79/ F	79	40	10	22
		Mean = 70.6	Mean = 73.4	Mean = 39.7	Mean = 17	Mean = 7.1	Mean = 13
8	Ozark	127	80/ F	80	60	12	19
9	Ozark	115	67/ F	58	50	12	25
10	Ozark	106	47/ M	47	30	10	16
11	Ozark	50	74/ M	74	50	6	8
12	Ozark	83	36/ M	36	16	11	16
13	Ozark	95	70/ F	70	50	13	23
14	Ozark	97	78/ F	78	60	15	26
		Mean = 96.1	Mean = 64.6	Mean = 63.3	Mean = 45.1	Mean = 11.3	Mean = 19

by each informant are also listed. As depicted in Table 5, the most expert of the informants are generally the granny-women, who provided the most information (numbers of plants and numbers of applications) about native medicinals.

A close examination of the data shows that the most knowledgeable of the granny-women are those who have lived for longer periods of time in their respective communities. It is these informants who have the most years of experience in curing with medicinal plants. When compared to the younger, less experienced male experts in the sample, granny-women emerge as true compendiums of botanical knowledge. This finding supports Wilkinson (1987), who suggests that folk medical knowledge in America has traditionally been the domain of elderly, experienced women whose social roles as healers have been essential within families in rural communities, much like the village *wise women* who served as folk curers in Old World History (McDonough 1975). Figure 2 illustrates the regression correlation between the length of folk practice (years of experience with wild plants) and the number of medicinal plant applications reported per informant. The r-squared value of .45 is highly significant ($p < .01$) and suggests that length of

FIGURE 2 — Correlation between length of informant experience in folk practice and level of medicinal plant knowledge demonstrated.

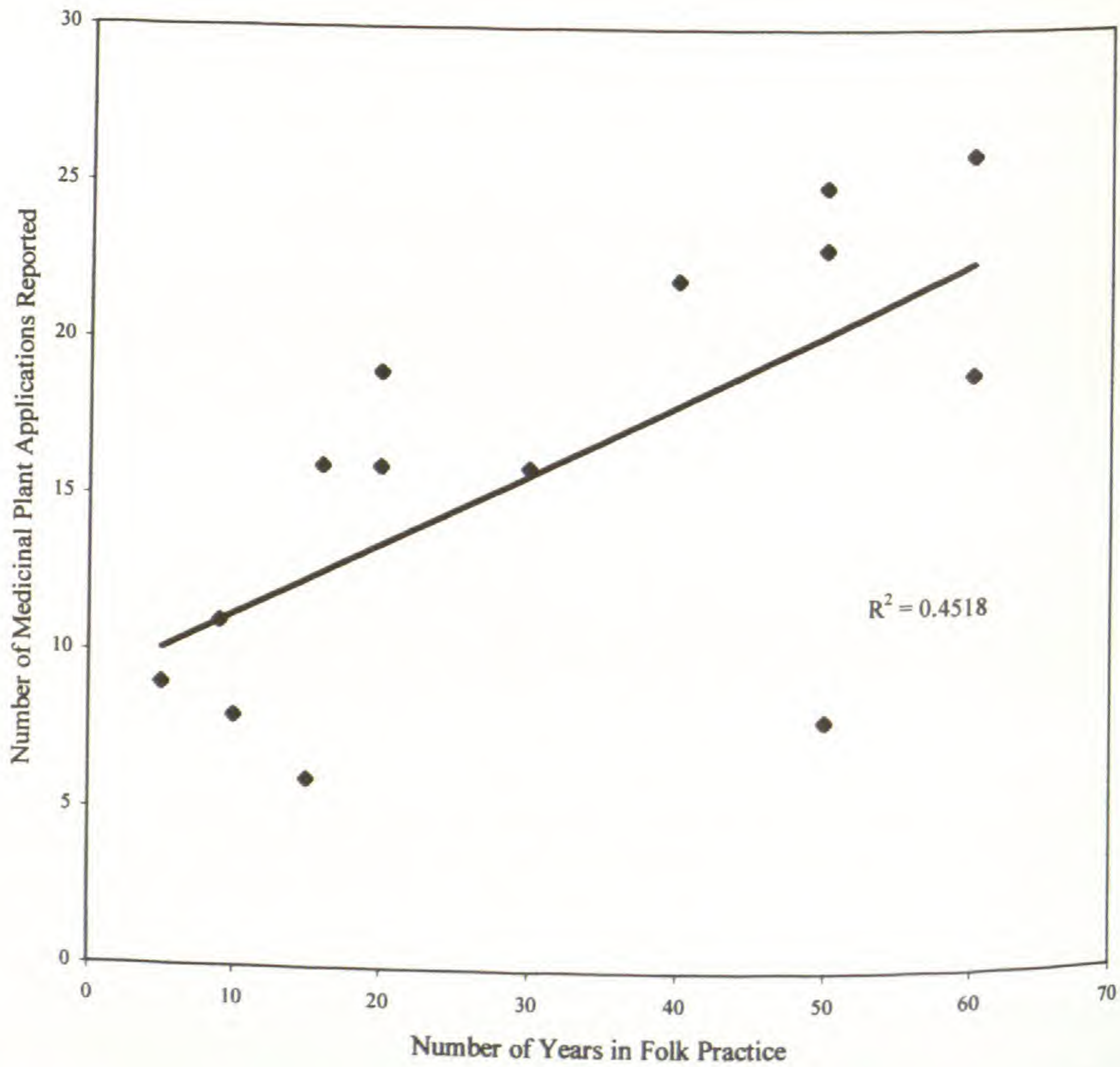
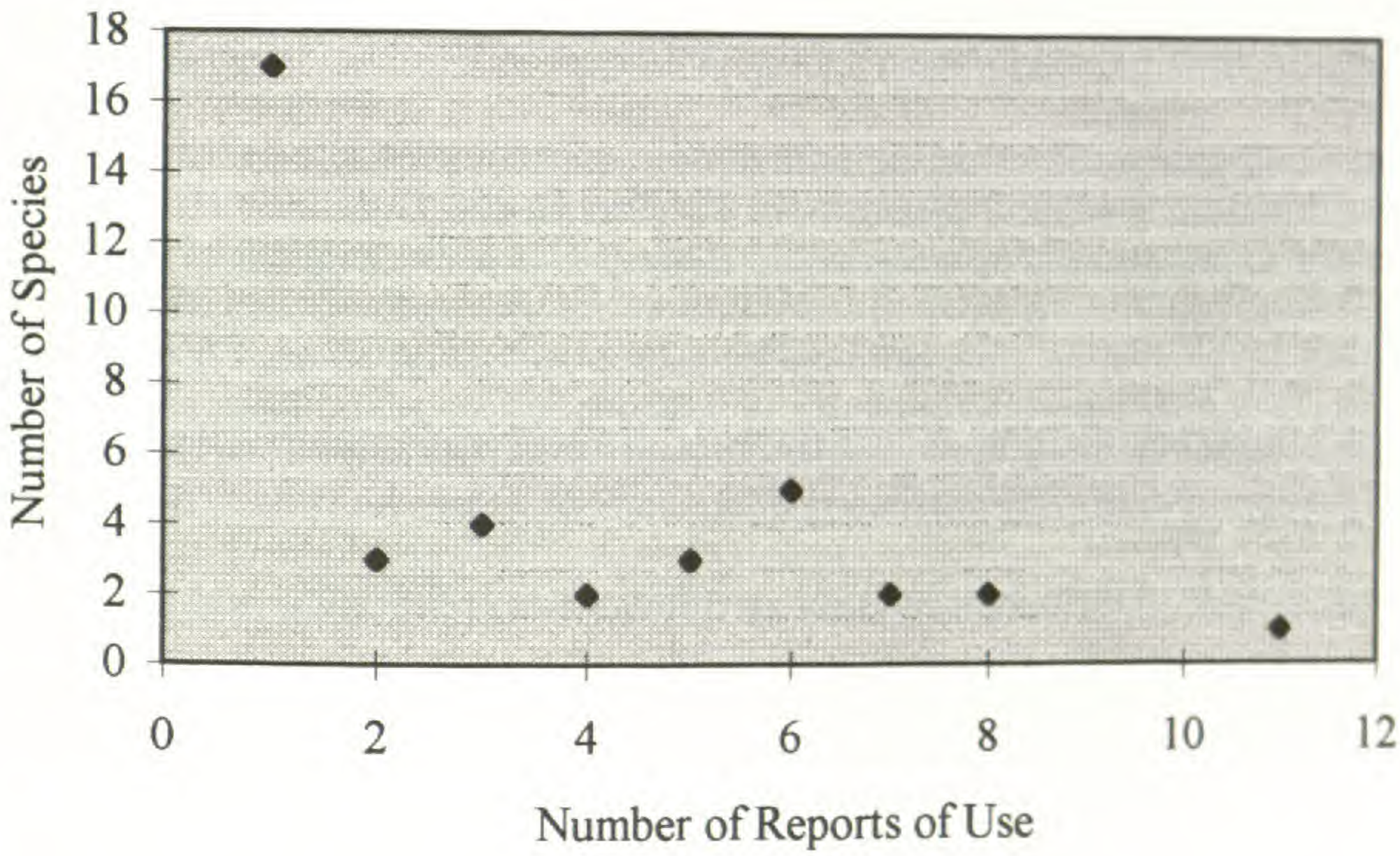


FIGURE 3 — Abundance diagram illustrating the number of reports of use for all species listed.



informant experience with plant procurement may explain the variance in the number of medicinal plant applications reported by experts from both regions.

Folk specialties and expert knowledge. Figure 3 displays the distribution of medicinal plant reports, or the number of reports of use for the plants mentioned in the free-list task. As is commonly observed in ethnobotanical inventories, several plants received only one report of use by a single informant. This pattern may be a reflection of the dissimilation of traditional knowledge (e.g., Benz *et al.* 1994), or alternately, a function of knowledge specialization among expert informants. For instance, throughout the interview process, it became evident that some experts, especially the granny-women, are fundamentally more experienced in treating certain kinds of health problems. Some granny-women specialize primarily in childhood diseases (i.e., colic, thrush) while others are more knowledgeable about treating chronic conditions associated with aging (i.e., rheumatism, arthritis). Experts with specialized knowledge listed more unique plants with medicinal applications in their corresponding area of expertise.

In contrast to the granny women who rely chiefly upon plant-based remedies, the male yarb doctors use a number of nonbotanical ingredients in their healing concoctions such as turpentine, whiskey, oils, and other solvents in which different plant parts are steeped or boiled (e.g., Randolph 1947). The knowledge of the yarb doctor frequently overlaps with that of the granny-woman, but appears have a more arcane and esoteric orientation. The root-diggers, who represent the youngest informants consulted in the sample, have the fewest years of experience with plants, which probably explains why these individuals supplied the fewest names and applications for wild medicinals. Unlike the folk medical practitioners, root-diggers do not generally act as dispensaries of medical knowledge within their

communities. Rather, root-diggers focus on procuring a limited number of plants, namely those that will bring an attractive price from commercial drug buyers. Thus, the folk specialty of the informants and their respective relationships with plants appear to have a significant effect on the level and type of knowledge reported.

Demographic and socioeconomic influences. — In a separate study on the cultural conservation of medicinal plant use in the Ozarks and Ouachitas (Nolan and Robbins, in press), a multiple regression analysis was performed using the number of plant applications reported and six relevant socioeconomic variables which include, in descending order of importance, 1) community distance from urban centers of 50,000, 2) number of county physicians, 3) yearly county retail sales, 4) county population density, 5) percent of county population over age 18, and 6) acres of county farms. A partial correlation analysis was performed to determine the relative order of magnitude for each variable. The partial correlation coefficients revealed that community distance from urban centers is the best predictor variable for the number of medicinal plant applications reported. In the same study, a multiple correlation coefficient of 0.84 was found, which indicates that a promising 71% of the variance in numbers of applications reported can be explained by the six variables combined.

As presented in Table 5, the Ozark communities in the study are essentially more isolated from cosmopolitan cultural influences than those in the Ouachita region. The average distance to the nearest urban location is 96.1 miles for Ozark communities and 70.6 miles for those in the Ouachitas, a difference which is statistically significant ($t = 2.34$, $p < .02$). Also responsible for the higher number of plants and applications reported in the Ozarks is length of folk practice among the experts. On average, Ozark informants have more experience with plants (45.1 years) than the Ouachita informants (17 years). This difference in means is very significant ($t = 3.7$, $p < .003$) and suggests that length of plant-based experience is useful for explaining the variation in medicinal plant knowledge *between* the two regions in addition to the variation observed among all fourteen informants.

Traditional knowledge and delocalization. In essence, the survival of traditional plant knowledge in the Ozarks and Ouachitas is inversely linked to what has been called *delocalization*. Delocalization is a form of modernization in which the members of a socioeconomic system become increasingly dependent upon exogenous, commercially distributed technologies (Pelto 1973:165). In the more delocalized Ouachita communities, experts offered far fewer names and treatments for native medicinal plants. Evidently, traditional botanical expertise has faded in the wake of cosmopolitan cultural influences, including the accessibility of trained health care professionals and the availability of modern medicine. Conversely, most of the Ozark communities are relatively detached from the larger framework of state socioeconomics. Often there are no physicians, clinics, or health services available within these isolated locales. The lack of health-care options, combined with light commerce, low population density, and age-old patterns of individual self-sufficiency, combine to explain the greater retention of traditional medical knowledge among experts from the Ozark region.

CONCLUSION

While the ecological contrast between the Ozarks and Ouachitas is quite apparent, this disparity has little effect on medicinal plant knowledge and use among local specialists. This conclusion is supported by two observations: (1) there is a highly significant correlation in plant use patterns between the informants from both regions, and (2) the vast majority of the reported plants occur in broad distribution across the entire Ozark-Ouachita study area, despite the apparent ecological heterogeneity. Vernacular knowledge of medicinal flora in the Highlands is therefore a construct of several interrelated sociodemographic and cultural factors. The length of the informants' experience with plants and the proximity of their home communities to cosmopolitan centers are the most sound explanations for the variation in medicinal plant knowledge observed among the experts consulted. On the collective level, however, common patterns of medicinal plant use endure among informants from both regions. The combined Ozark-Ouachita pharmacopoeia contains many of the same plants still in use among the hill dwellers of Southern Appalachia, the region's most proximal cultural source area. Some of the reported species were historically significant in the traditional medicine of the British Isles, the ancestral homeland for many contemporary hill folk in the Interior Highlands. This cultural perpetuation of medicinal plant knowledge indicates that firmly rooted social and historical traditions are important factors accounting for the similarity in plant use patterns.

There are few studies that document the use of wild plant resources in the American Interior. A wealth of ethnobotanical information remains untapped across the backwoods of the Midwest, and the need to recover it is hastened by the dissolution of rural family life and the social effects of modernization (Nearing 1996). The notion that medicinal plant knowledge is a construct of cultural factors first and ecological factors second bears important implications for future studies in ethnobotany. Researchers should acknowledge that the survival of traditional lifeways and knowledge is dependent upon a number of interconnected socioeconomic, demographic, and ecological variables. By recognizing this, it may be possible to safeguard irreplaceable knowledge on our forests' native species and to design policies for conserving the cultures that harbor this information.

NOTES

[1]In a study of the folk speech patterns of the Interior Highlands, Randolph and Wilson (1953) group the people of the Ozarks and Ouachitas together because they share similar vernacular dialects; this is considered a function of common ancestry and folk heritage. Other folklorists who have studied the customs and beliefs of the people of the Ozarks and Ouachitas similarly describe them as members of the same Upland South cultural tradition (e.g., Brown 1992; McDonough 1975; Randolph 1964).

[2]Like other studies based on a relatively small sample of informants, it is presumed here that each expert represents the *minimum* level of esoteric knowledge within their respective communities.

[3]All medicinal plant applications given by the informants were indicated for the straightforward relief of symptoms or illness resolution.

[4]In addition to richness and evenness, there is a third component of diversity-density: the size of each species population. The nature of the available data called for an index that takes into account richness and evenness as a comparative measure of diversity.

[5]The high concentration of softwood in the Ouachita mountains is also a result of years of intensive timber extraction by regional lumber industries. The Ozarks, by contrast, have been subjected to less timber removal over recent decades, resulting in a somewhat more pristine woodland region.

ACKNOWLEDGEMENTS

I would like to express my appreciation to a number of individuals for offering constructive comments on the original draft of this manuscript, including my advisors Deborah Pearsall and Mike Robbins, as well as Mike Amspoker, Louanna Furbee, and Clyde Wilson. I am grateful to the JEB editor and to three anonymous JEB reviewers whose editorial suggestions have enhanced this manuscript significantly. I would like to extend a special thank you to Marsha Quinlan and Susan Wilson for sharing your foreign language skills in the translation of the abstract. Finally, I thank the good people of the Ozarks and Ouachitas for entrusting me with their knowledge of the forests and its healing plants.

LITERATURE CITED

ALCORN, JANIS B. 1995. The scope and aims of ethnobotany in a developing world. Pp. 23-39 *in* Ethnobotany: Evolution of a Discipline, Richard Evans Schultes and Siri Von Reis (editors). Dioscorides Press, Portland, Oregon.

ALLEN, JAMES LANE. 1995. Through Cumberland Gap on horseback. Pp. 59-74 *in* Appalachian Images in Folk and Popular Culture, W. K. McNeil (editor). University of Tennessee Press, Knoxville.

BEGOSSI, ALPINA. 1996. Use of ecological methods in ethnobotany: Diversity indices. Economic Botany 50(3):280-289.

BENZ, BRUCE F., FRANCISCO SANTANA M., ROSARIO PINEDA L., JUDITH CEVALLOS E., LUIS ROBLES H., and DOMITILA de NIZ L. 1994. Characterization of Mestizo plant use in the Sierra de Manantlan, Jalisco-Colima, Mexico. Journal of Ethnobiology 14(1):23-42.

BERNARD, H. RUSSELL. 1994. Research Methods in Anthropology. Sage Publications, Thousands Oaks, California.

BROWN, SARAH. 1992. Folk architecture in Arkansas. Pp. 155-172 *in* An Arkansas Folklore Sourcebook, W. K. McNeil and William M. Clements (editors). University of Arkansas Press, Fayetteville.

BRUSH, STEPHEN B. 1996. Whose knowledge, whose genes, whose rights? Pp. 1-24 *in* Valuing Local Knowledge: Indigenous People and Intellectual Property Rights, Stephen B. Brush and Doren Stabinsky (editors). Island Press, Washington D.C.

DENISON, EDGAR. 1991. Missouri Wildflowers. Missouri Department of Conservation, Jefferson City.

EHRENREICH, JOHN H. and JOHN S. CROSBY. 1960. Herbage production is related to hardwood crown cover. Journal of Forestry 58(7):564-565.

ETKIN, NINA L. 1990. Ethnopharmacology: Biological and behavioral perspectives in the study of indigenous medicines. Pp. 149-158 *in* Medical Anthropology: Contemporary Theory and Method, Thomas M. Johnson and Carolyn F. Sargent (editors). Praeger, New York.

FALINSKA, K. 1985. The demography of coenopopulations of forest herbs. Pp. 241-264 *in* The Population Structure of Vegetation, J. White (editor). Dr. W. Junk The Publishers, Dordrecht, Netherlands.

FOTI, THOMAS and MARGARET S. DEVALL. 1994. Herbaceous plant biodiversity of stands in the Ouachita and Ozark National Forests. Pp. 50-60 *in* Ecosystem Management Research in the Ouachita Mountains: Pretreatment Conditions and Preliminary Findings,. United States Department of Agriculture: Southern Forest Experiment Station, New Orleans, Louisiana.

——— and JAMES M. GULDIN. 1994. Multivariate analysis of the ground cover layer, shrub layer, midstory, and overstory of the Ouachita/Ozark National Forests. Pp. 61-73 *in* Ecosystem Management Research in the Ouachita Mountains: Pretreatment Conditions and Preliminary Findings,. United States Department of Agriculture: Southern Forest Experiment Station, New Orleans, Louisiana.

FREETHY, RON. 1985. From Agar to Zenry: A Book of Plant Uses, Names, and Folklore. Tanager Books, Dover, New Hampshire.

GERLACH, RUSSEL L. 1986. Settlement Patterns in Missouri: A Study of Population Origins. University of Missouri Press, Columbia.

GIBBENS, BYRD. 1992. Customs and beliefs. Pp. 155-172 *in* An Arkansas Folklore Sourcebook, W. K. McNeil and William M. Clements (editors). The University of Arkansas Press, Fayetteville.

HENSLEY, JOHN R. 1987. The need for a broader perspective in the study of Ozark history. Mid-America Folklore 15(1):21-26.

HINES, F. DEE. 1988a. Forest Statistics for Arkansas' Ozarks Counties. United States Department of Agriculture Forest Service: Southern Forest Experiment Station, New Orleans, Louisiana.

———. 1988b. Forest Statistics for Arkansas' Ouachita Counties. United States Department of Agriculture Forest Service: Southern Forest Experiment Station, New Orleans, Louisiana.

HUNTER, CARL G. 1984. Wildflowers of Arkansas. Ozark Society Foundation and Arkansas Game and Fish Commission, Little Rock.

———. 1989. Trees, Shrubs, and Vines of Arkansas. The Ozark Society Foundation, Little Rock, Arkansas.

MAGURRAN, A. 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton, New Jersey.

MARTIN, GARY J. 1995. Ethnobotany: A Methods Manual. Chapman and Hall, London.

McDONOUGH, NANCY. 1975. Garden Sass: A Catalogue of Arkansas Folkways. Coward, McCann, and Geoghegan, New York.

McNEIL, W. K. 1992. Folklore studies in Arkansas. Pp. 31-56 *in* An Arkansas Folklore Sourcebook, W. K. McNeil and William M. Clements (editors). The University of Arkansas Press, Fayetteville.

MOERMAN, DANIEL E. 1979. Symbols and selectivity. Journal of Ethnopharmacology 1:111-119.

———. 1989. Poisoned apples and honeysuckles: The medicinal plants of Native America. Medical Anthropology Quarterly 3:52-61.

MOORE, DWIGHT M. 1988. Trees of Arkansas. Arkansas Forestry Commission, Little Rock.

MURPHY, DEAN A. and HEWLETTE S. CRAWFORD. 1970. Wildlife Foods and Understory Vegetation in Missouri's National Forests. Missouri Department of Conservation, Jefferson City.

——— and JOHN H. EHRENREICH. 1965. Fruit-producing trees and shrubs in Missouri's Ozark forests. Journal of Wildlife Management 29(3):497-503.

NEARING, HELEN. 1996. Living the good life. Pp. 312-320 *in* The Ecology of Health: Identifying Issues and Alternatives, Jennifer Chesworth (editor). Sage Publications, Thousand Oaks, California.

NOLAN, JUSTIN M. and MICHAEL C. ROBBINS. 1998. Cultural conservation of medicinal plant use in the Ozark-Ouachita Mountains. Human Organization, in press.

PARKER, H. JANE. 1992. Engendering identity in a rural Arkansas Ozark community. Anthropological Quarterly 65:38-52.

PRICE, EDWARD T. 1998. Root digging in the Appalachians: The geography of botanical drugs. Pp. 242-276 *in* Baseball, Barns and Bluegrass: A Geography of American Folklife, George O. Carney (editor). Rowman and Littlefield Publishers, Lanham, Maryland.

RAFFERTY, MILTON D. 1987. Changing economy and landscape in the Ozark-Ouachita highland. Mid-America Folklore 15(1):4-20.

———. 1980. The Ozarks: Land and Life. University of Oklahoma Press, Norman.

——— and JOHN C. CATAU. 1991. The Ouachita Mountains. University of Oklahoma Press, Norman and London.

RAITZ, KARL B. and RICHARD ULACK. 1984. Appalachia: A Regional Geography: Land, People, Development. Westview Press, Boulder, Colorado.

RANDLOPH, VANCE. 1947. Ozark Magic and Folklore. Reprint, 1964. Dover Publications, New York.

——— and GEORGE P. WILSON. 1953. Down in the Holler: A Gallery of Ozark Folk Speech. University of Oklahoma Press, Norman.

READ, RALPH A. 1951. Woodland forage in the Arkansas Ozarks. Journal of Range Management 4:391-396.

ROBBINS, MICHAEL C. and JUSTIN M. NOLAN. 1997. A measure of dichotomous Category bias in free-listing tasks. Cultural Anthropology Methods Journal 9(3):8-12.

ROSSITER, PHYLLIS. 1992. A Living History of the Ozarks. Pelican Publishing Company, Gretna, Louisiana.

RUPP, REBECCA. 1990. Red Oaks and Black Birches: The Science and Lore of Trees. Storey Communications, Pownal, Vermont.

SABO, GEORGE, ANN M. EARLY, JEROME C. ROSE, and BARBARA A. BURNETT. 1990. Ozark-Arkansas-Ouachita adaptation types. Pp. 221-252. *in* Human Adaptation in the Ozark-Ouachita Mountains, George Sabo, Ann M. Early, Jerome C. Rose, Barbara A. Burnett, Louis Vogele, Jr., and James P. Harcourt (editors). Arkansas Archaeological Survey, Fayetteville.

TURNER, NANCY J. 1988. The importance of a rose: Evaluating the cultural significance of plants. American Anthropologist 90:272-290.

UNKELSBAY, A. G. and JERRY D. VINEYARD. 1992. Missouri Geology: Three Billion Years of Volcanoes, Seas, Sediments and Erosion. University of Missouri Press, Columbia.

VOGELE, LOUIS E. 1990. Environmental setting. Pp.3-14 *in* Human Adaptation in the Ozark-Ouachita Mountains, George Sabo, Ann M. Early, Jerome C. Rose, Barbara A. Burnett, Louis Vogele, Jr., and James P. Harcourt (editors). Arkansas Archaeological Survey, Fayetteville.

WILKINSON, DORIS Y. 1987. Traditional medicine in American families: Reliance on the wisdom of elders. Marriage and Family Review 11(3-4):65-76.

WILLIAMS, MICHAEL ANN. 1995. Great Smoky Mountains Folklife. University Press of Mississippi, Jackson.

APPENDIX. — Inventory of reported plants and medicinal applications.

Family	Species	Common Name	Medicinal Use(s)	Part(s) Used
Anacardiaceae	*Rhus aromatica L.*	Sumac	colds, fevers, diarrhea	berries, leaves
Apiaceae	*Eryngium yuccafolium L.*	Snakeroot	snakebite	roots
Araceae	*Arisaema atrorubens Mart.*	Indian turnip	asthma, rheumatism	roots
Araliaceae	*Panax quinquefolius L.*	Ginseng	stimulant, cure-all	roots
Asclepiadaceae	*Asclepias sp.*	Milkweed	kidney pain, warts	plant
Asteraceae	*Solidago sp.*	Goldenrod	indigestion, fatigue	flowers, leaves
Balsaminaceae	*Impatiens capensis L.*	Jewelweed	poison ivy	leaves
Berberidaceae	*Podophyllum peltatum L.*	May Apple	colds, fevers	fruit
Betulaceae	*Betula nigra L.*	River Birch	wounds, urinary pain	bark
Betulceae	*Alnus serrulata Mill.*	Alder	sore throat	inner bark
Boraginaceae	*Lithospermum incisum L.*	Yellow Puccoon	stomach pain, vomiting	roots
Campanulaceae	*Lobelia sp.*	Lobelia	pneumonia	leaves, flowers
Cornaceae	*Cornus sp.*	Dogwood	fever, diarrhea, malaise	bark, berries
Cupressaceae	*Juniperus virginiana L.*	Juniper	dropsy, bronchitis, heartburn	berries
Fagaceae	*Castanea pumila Mill.*	Chinquapin	constipation	nuts
Geraniaceae	*Geranium sp.*	Crane's Bill	sore throat	stems, leaves
Hamamelidaceae	*Hamamelis virginiana L.*	Witch Hazel	wounds, infections, diarrhea	bark
Hamamelidaceae	*Liquidambar styracifula L.*	Sweet Gum	expectorant, skin rashes	balsam
Juglandaceae	*Juglans nigra L.*	Black Walnut	ringworm, diarrhea	bark, fruit rind
Juglandaceae	*Carya texana Nutt.*	Hickory	asthma	bark
Lamiaceae	*Prunella vulgaris L.*	Heal-All	ulcers, blood purifier, thrush	leaves
Lamiaceae	*Monarda spp.*	Mint, Horsemint	insomnia, nausea, coughing	leaves
Lauraceae	*Sassafras albidum Nees*	Sassafras	fever, pain, blood purifier	roots, bark
Liliaceae	*Allium stellatum L.*	Wild Onion	high blood pressure, heartburn	bulb
Magnoliaceae	*Magnolia tripetala L.*	Magnolia	colds	bark
Moraceae	*Morus rubra L.*	Mulberry	laxative	bark
Myricaceae	*Myrica cerifera L.*	Wax Myrtle	wounds, dysentary	bark, leaves
Oleaceae	*Fraxinus quadrangulata L.*	Blue Ash	laxative	fruit
Passifloraceae	*Passiflora incarnata L.*	Passion Flower	tension	fruit, seeds
Phytolaccaceae	*Phytolacca americana L.*	Pokeweed	pain, arthritis	leaves, roots
Ranunculaceae	*Hydrastis canadensis L.*	Golden Seal	infections, stomach pain, purifier	roots
Rhamnaceae	*Rhamnus caroliniana L.*	Buckthorn	laxative	bark
Rosaceae	*Prunus serotina L.*	Black Cherry	colds, coughing, kidney pain	bark
Rosaceae	*Rubus spp.*	Blackberry	colds, coughing, diarrhea	roots
Rutaceae	*Zanthoxylum americanum L.*	Toothache Tree	tooth pain, rheumatism	bark
Salicaceae	*Populus alba L.*	Poplar	wounds	buds
Salicaceae	*Salix sp.*	Willow	fever, arthritis	bark
Tiliaceae	*Tilia americana L.*	Basswood	colds	flowers
Ulmaceae	*Ulmus rubra L.*	Slippery Elm	sore throat, dysentary	bark

Report on the Staten Island Project: The Ibogaine Story. Paul De Rienzo, Dana Beal and unnamed "members of the project." Autonomedia, Brooklyn, New York:, P.O. Box 568 Williamsburgh Station, 11211-0568. 1997. Pp. 352, numerous B/W illustrations and tables; six appendices; no bibliography; no index. US$15.95 (paperback). ISBN 1-57027-029-5.

In a personal narrative style, this large-format paperback recounts a tale of contemporary ethnobotany in the heart of the industrialized world, yet in some strange, otherworldly penumbra between the shamanic realm and research laboratory; the pharmaceutical industry and herb-market; the forefront of high-tech drug-development and the back-alley underworld of black-market-drugs. Ostensibly the story of a quixotic quest to promote the indole alkaloid ibogaine (from African *Tabernanthe iboga* Baillon [Apocynaceae] roots) as a "cure for addiction," it alloys mysticism with science; politics with pharmacology; in the end, alas, specious speculation with sincere spirituality. Primarily the story of Howard Lotsof's assiduous endeavor to establish ibogaine as pharmacotherapy for opioid, alcohol, nicotine and other addictions (under cover of patents on such use of this natural product, trade-named *Endabuse*®). *The Ibogaine Story* is likewise a conspiracy theory/*exposé* in the well-worn US genre (cf., the ominous obverse-cover rhetorical question: "has the cure for addiction been suppressed since the '60s?"), and also the subtextual assertion of a speculative theory of dream, memory, and consciousness. As a result, within this matrix of personal-narrative saga, the book veers vertiginously from experimental anti-addiction therapy in the junkie scene, to neurochemical data from animal experiments; from Fang initiations using massive doses of *iboga* root in Gabon's Bwiti religion (Fernandez 1982), to political demonstrations in the US; from Philip K. Dick's novel *Valis,* to Gnosticism and Rabbi Hugh Schonfield's *The Passover Plot;* from REM sleep to rioting radicals; heroin to *haama* just to name a few of the plot twists. While some will indubitably find this entertaining, few will find it enlightening, since the presentation is so confusingly vague; and those with scientific training or plain healthy scepticism will marvel at how the authors arrive at the following conclusion: Ibogaine triggers the NDE [near-death experience] reflex chemically... turns the serotoninergic and cholinergic pathways into a super-augmented, "sterescopic" [?] entity, capable of scanning ancestral memory in the non-nucleated genetic material of your [*sic.*] cells" (pg. 121). In the end, while allowing "there are, of course, many other explanations for all of these things," they immodestly assert, "but no other single explanation *so elegantly explains everything*" (italics mine). Ibogaine, of course, is a Schedule I controlled-drug like heroin or LSD, and there is no question the US "drug abuse" research establishment is not interested in funding therapeutic study of drugs it has defined as having "no currently accepted medical use." Given our rigid, physician/pharmacist "duopoly" and excessive regulation of the pharmaceutical trade, drug companies in general have little interest in unpatentable natural products — but does this constitute a *conspiracy* to "suppress" a "cure for addiction"? Clearly, this is neither the time nor place to evaluate any theory which will purportedly "elegantly explain everything," hence I will confine my remarks to *The Ibogaine Story* at its face.

Long used ethnomedicinally in equatorial Africa (Andoh 1987), *iboga* root extracts were for a time employed as a stimulant in western medicine under the

trade-names *Lambarene®* and *Iperton®* (Popik *et al.* 1995). Ibogaine came to the attention of sixties "psychedelic" users largely *via* its use in psychotherapy, notably by Naranjo (Naranjo 1973). It was as illicit "psychedelic" drug that Howard Lotsof encountered ibogaine. After its long-lasting "trip" faded, he discovered to his amazement that "for the first time in months, I did not want or need to go cop heroin," leading him to make informal trials of the drug with fellow opioid habitués, some of whom also stopped using heroin, although they "had not gone through withdrawal." By fits and starts, *The Ibogaine Story* recounts how Lotsof went from amazed ex-opioid habitué to prime partisan of ibogaine as "addiction interrupter," including more extensive trials in Holland, one of which led to the tragic death of a young German woman, apparently from ibogaine overdose (she had been given a total of 4 grams). The book also details the interactions of Lotsof's *Endabuse®* company with various research scientists, mainly in the US, of whom the best known is neurochemist Deborah C. Mash of the University of Miami. She was able to obtain an Investigational New Drug permit from the Food and Drug Administration for Phase I clinical (basic-toxicity) trials of ibogaine in human beings, and Mash discovered it was likely the metabolite nor-ibogaine, which showed long-lasting opioid-receptor activity, that explained the drug's persistent amelioration of the opioid withdrawal syndrome. Mash has recently formed her own company, Healing Visions, and is now conducting Phase I clinical trials of the drug in her offshore (Caribbean) clinic (Sanchez-Ramos and Mash 1996), which might lead to eventual availability of ibogaine, nor-ibogaine, or artificial analogues as prescription medicines for treatment of drug habituations.

For all its bombast and confusion, *The Ibogaine Story* contains much useful information, though it would have been far better to separate this from personal reminiscences and speculative theories of consciousness, distilling the story down to perhaps 100 pages. Even as such, the book desperately needs an index (ironically, there is a 17-page index to a lengthy appendix, a reprint of D.S. Flattery and M. Schwartz' 1989 *Haama and Harmaline...*), and it adds insult to injury to discover *four full pages of advertisements* for the publisher's other books in its stead! There are also far too many misprints and innumerable minor technical errors, and if a second edition ensues, the publisher would do well to hire a professional copy editor and seek out a capable technical editor, since much of the material is clearly beyond the technical expertise of the authors. Nevertheless, The *Ibogaine Story is* a unique tale of an ancient African ethnomedicine finding its way into university and pharmaceutical company laboratories, not via ethnobotanical expeditions to Africa, but via folk medicine (some would say "hippy illicit-drug abuse") in the United States and Europe — via the "streetdrug scene"! Not only have black-market chemists discovered valuable new drugs (such as the highly-potent and economical opioid a-methyl-fentanyl and short-acting amphetamine methylcathinone), and by their errors led to scientific breakthroughs (like the discovery of Parkinsonism neurotoxin MPP^+ from illicit-opioid samples), but here we have discovery of a potentially-valuable new use for an ancient drug, from the ethnopharmacopaeia of the ilicit drug *demimonde* — all the more reason for ethnobotanists to direct their research attentions also to contemporary drug cultures and subcultures.

LITERATURE CITED

ANDOH, A K. 1987. The Science and Romance of Selected Herbs Used in Medicine and Religious Ceremony. The North Scale Institute, San Francisco, California.

FERNANDEZ, J.W. 1982. Bwiti: An Ethnography of the Religious Imagination in Africa. Princeton University Press, Princeton, New Jersey.

NARANJO, C. 1973. The Healing Journey: New Approaches to Consciousness. Pantheon Books, New York, New, York.

POPIK, P. *et al.* 1995. 100 years of ibogaine: Neurochemical and pharmacological actions of a putative anti-addiction drug. Pharmacological Reviews 17(2): 235-253.

SANCHEZ-RAMOS, J.R. and D.M. MASH. 1995[6]. Pharmacotherapy of drug-dependence with ibogaine. Jahrbuch fur Transkulturelle Medizin und Psychotherapie. Verlag für Wissenschaft und Bildung, Berlin, Germany 6:353-367.

Jonathan Ott, President
Natural Products Co.
Apartado Postal 532
Xalapa, Veracruz, México

Journal of Ethnobiology 18(2):273-308 Winter 1998

PLANT FOOD RESOURCE RANKING ON THE UPPER KLAMATH RIVER OF OREGON AND CALIFORNIA: A METHODOLOGY WITH ARCHAEOLOGICAL APPLICATIONS

DONN L. TODT
Ashland Parks Department
340 S. Pioneer, Ashland OR 97520

NAN HANNON
Department of Anthropology
Southern Oregon University
Ashland OR 97520

ABSTRACT. — Ethnographic, biogeographic, nutritional and experimental data are used to rank the relative value of plant food resources available in the precontact period to indigenous peoples of the Upper Klamath River. The regional ethnographic record identifies more than 60 food plants which grow within the study area, located in the western United States, along the Oregon-California border. Analysis indicates that only a modest number are ranked highly enough to have appreciably influenced food procurement strategies. The most important of these are *Quercus garryana, Q. kelloggii, Perideridia* spp., *Pinus lambertiana, Madia* spp., *Pinus ponderosa* and several Rosaceae species. The plants which would have been most amenable to intensification are in the *Quercus* and *Perideridia* genera. Many of the remaining plants tend to be erratic producers, have restricted range distributions, have low caloric return rates or evidence some combination of these factors. This information supplements the archaeological record, suggests archaeological applications, and helps clarify the relationship between indigenous peoples and food resources along the Upper Klamath River. While this study focuses on a particular location, the methodology used for this analysis may have a broader utility in the evaluation of the role of plant foods in hunter-gatherer diets.

RESUMEN. — Datos etnográficos, biogeográficos, nutricionales y experimentales son usados para categorizar el valor relativo de los recursos alimenticios de las plantas disponibles en el periodo de pre-contacto a la gente indígena del "Upper Klamath River." El récord etnográfico regional identifica más de 60 plantas alimenticias las cuales crecen dentro del area de estudio, localizada en el oeste de los Estados Unidos, y a lo largo de la frontera de Oregon y California. Los análisis indican que solamente un modesto número de plantas tienen un grado suficientemente alto de valor relativo para ser consideradas como estratégicas para su obtención. Las más importantes de éstas son: *Quercus garryana, Q. kelloggii, Perideridia* spp., *Pinus lambertiana, Madia* spp., *Pinus ponderosa* y varias especies de la Rosaceae. Las plantas más sensibles a la intensificación pudieron haber sido la *Quercus* y la *Perideridia*. Muchas de las otras plantas restantes tienden a ser erráticas productoras, tienen rangos restringidos de producción, producen bajos niveles de calorias o muestran la combinación de alguno de estos factores. Esta información de ambos suplementos el récord arqueológicas sugeridas puede ser usada para tener un mejor conocimiento de las relaciones entre los indígenas y los recursos

del "Upper Klamath River." Mientras este estudio se enfoca en una zona particular, la metología usada por este análisis podría tener una utilizacíon más amplia en la evaluación del papel de la comida de plantas para la dieta de los cazadores/ recogedores.

RÉSUMÉ. — Les données ethnographiques, biogéographiques, alimentaires et expérimentales sont utilisées pour classer la valeur relative des resources des plantes alimentaires disponibles aux les peuples autochtones qui habitaient près du haut Fleuve Klamath avant 1827 (date du premier contact avec les Européens). Les données régionales ethnographique relèvent plus de soixante plantes alimentaires qui poussent dans la région où l'étude prend place à l'ouest des Etats-Unis à la frontière entre l'Oregon et la Californie. Les analyses indiquent que seulement un nombre très modeste de ces plantes sont classées suffisamment hautes pour avoir exercé d'une façon importante une influence sur les stratégies d'obtention alimentaire. Parmi les plus importantes sont *Quercus garryana, Q. kelloggii,* les espèces *Perideridia,* les espèces *Madia, Pinus ponderosa,* et plusiers espèces Rosaceae. Les plantes qui auraient été les mieux disposées á une intensification sont parmi les genres *Quercus* et *Perideridia*. Beaucoup des plantes qui restent ont tendance à se reproudire d'une façon irrégulière et capricieuse, ont également une distribution de portée limitée, possèdent une quantité insuffisante d'energie thermique où bien font preuve de combinaison des facteurs. Ces renseignements s'ajoutent aux données archéologiques, suggèrent des applications archéologiques, et aident à mettre au point le rapport qui existe entre les peuples indigènes et les resources alimentaires du haut Klamath. Tandis que cette étude se concentre sur un endroit précis, la méthodologie utilisées pour cette analyse aurait peut-être des applications plus larges dans l'évaluation du rôle des plantes alimentaires dans le régime des peuples chasseurs-cuilleurs.

What we know suggests that analysis of landscapes in terms of the distribution and abundance of food...will lead directly to the elucidation of archaeological site distribution...

C. Melvin Aikens (1982:152)

INTRODUCTION

Plant food resource ranking provides a research methodology which may prove particularly useful where traditional food procurement practices are no longer in place. It is a theoretically motivated method of ordering the ethnobotanically relevant elements of a regional or local flora into a hierarchy which suggests both predictive and retrodictive applications. Its deductive approach yields hypotheses which may be incorporated into archaeological research designs and tested against the independent archaeological record. While this assessment focuses on a particular region, the methodology may be more broadly applicable and have particular value for archaeobotanical evaluations and diet reconstruction.

The archaeological evidence for resource use in the Far West is strongly weighted toward the recognition and evaluation of animal rather than plant food resources. However, plant food gathering constitutes an important component of the subsistence strategies of many hunting-gathering peoples, influencing the lo-

cations of living sites, task sites, and patterns of seasonal movement. Nutritional data strongly suggest that plant-derived carbohydrates are an essential part of most diets, especially of diets having a high proportion of lean animal foods (Speth and Spielmann 1983; King 1994:197). Researchers in various locations are developing methods to evaluate the role of plant foods in hunter-gatherer diets. Using ethnographic information, Hunn (1981) has reassessed the role of carbohydrate foods and concomitantly the economic contribution of women on the Columbia Plateau. Turner (1988) used data from two Interior Salish groups in British Columbia to develop a methodology for the evaluation of the relative importance of plants within traditional cultures. Recent archaeological work in the Fort Rock, Oregon, vicinity addresses the context of plant food use among the early inhabitants of that region (Aikens and Jenkins 1994; Prouty 1995). While description has been the foundation of ethnobotany, description may be enhanced through the quantification of measurable values (Prance *et al* 1987; Phillips and Gentry 1993). This paper outlines an approach to the quantification of the relative dietary value of specific plants available to the indigenous people who lived along the Upper Klamath River in the vicinity of the Oregon-California border. In the proto-historic period, the Shasta people were most closely associated with the study area, although the Klamath and Modoc peoples may have used portions of the area for resource procurement (Figure 1).

Anthropological literature pertaining to this region is sparse, and with a few exceptions, obscure. Ethnographic material pertaining to the Upper Klamath River region has been summarized by Theodoratus (1991:9-17). A range of perspectives

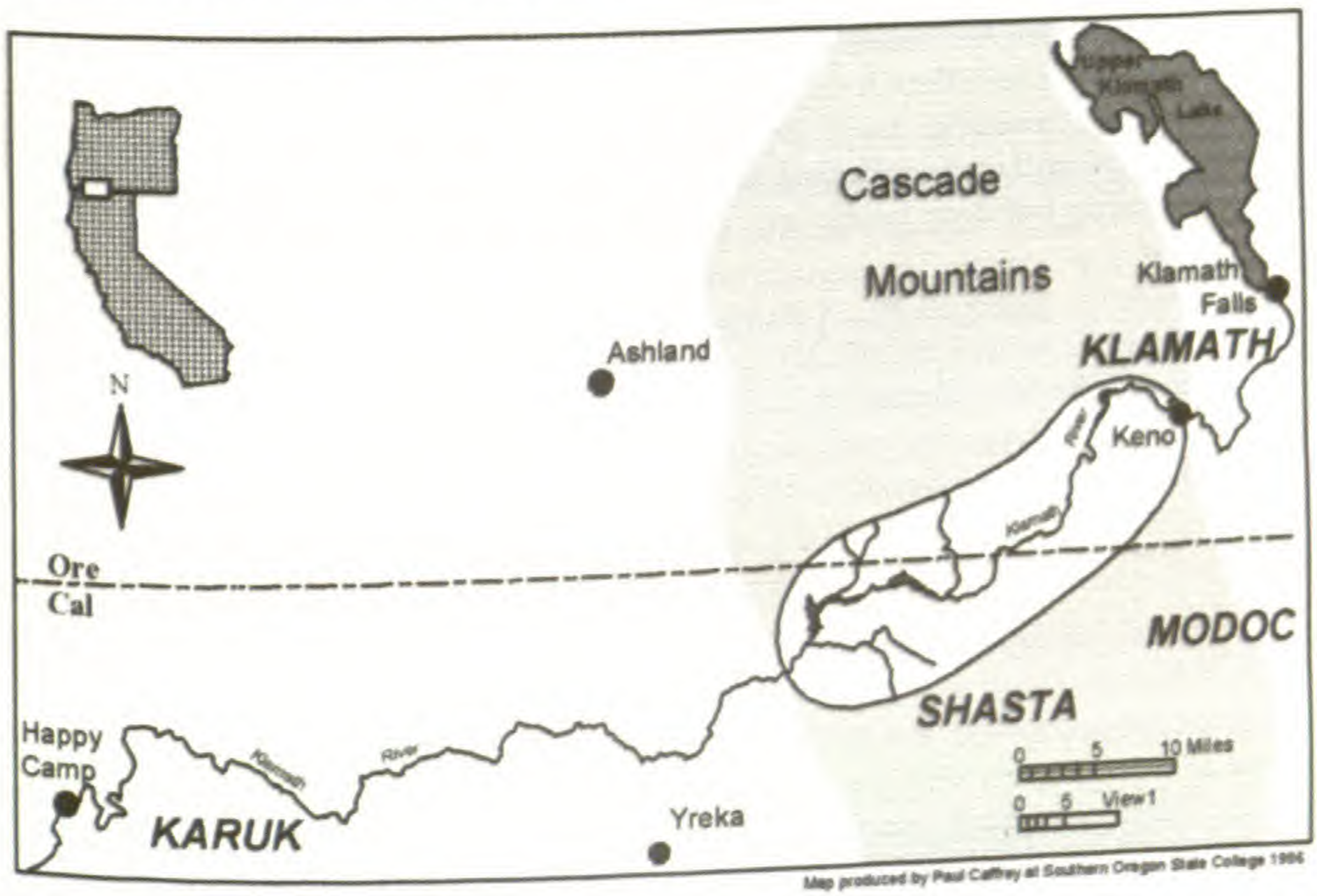


FIGURE 1. — Map of study area showing general locations of ethnographic groups discussed in the text. Map by Paul Caffrey, Department of Geography, Southern Oregon University.

on the prehistory of the region may be found in Hannon and Olmo (1990). Archaeological research in the area was sporadic until the mid-1980s (Newman and Cressman 1959; Cressman and Wells 1962; Leonhardy 1961; Anderson and Cole 1964; Cole 1965; Mack 1979, 1983; Jensen and Farber 1982; Gehr 1985, 1986a, 1986b; Jensen 1987). Mack (1991) recently synthesized this research. Archaeological investigation has identified numerous small temporary camps, large temporary camps, and more permanent habitation sites within the project area. Mack (1991:42) suggests that people continuously used the upper Klamath River vicinity from approximately 7500 years ago through the proto-historic period. Ethnobotanical research for the study reported here is being conducted in conjunction with archaeological investigations which began during the 1992 field season, in which Mack serves as principal investigator.

The working plant list for the project area includes more than 60 species identified as food resources in the regional ethnographic record.[1] During the precontact period, these plants exhibited a range of significance for the people who inhabited the area; some likely drove resource procurement strategies while others were harvested infrequently and opportunistically. Ideally, evaluations of the importance of food resources should be accomplished by Native People living within the context of traditional cultures (Turner 1988:274). However, in the Upper Klamath River region, traditional food procurement systems have not been in place since the late 19th century and a limited body of ethnographic data exists pertaining to resource procurement. In the absence of robust and site specific ethnographic data, this paper uses biogeographic, regional ethnographic, and nutritional data to estimate the relative dietary value of plant food resources for indigenous peoples. The goal is to retrodict the multi-component environmental information system that may have guided plant food procurement behaviors. Plant food resource ranking may have heuristic value in supplementing and helping to interpret the archaeological and archaeobotanical record, leading to a better understanding of the relationship between prehistoric peoples and resources along the Upper Klamath River.

The specific applicability of these data are limited in space and time. Spatially they apply only to the Cascade Mountain portion of the upper Klamath River and its adjacent uplands. Chronologically they apply to that period of time during which the present general climatic regime has been in effect, approximately the past 4000 years. Climate-mediated discontinuities in plant distributions, abundance and productivity prior to 4000 B.P. make observations based on present vegetation patterns much less applicable.

Physiographic setting. — The Klamath River drains the shallow lakes and marshes of the Klamath Basin along the southern Oregon-northern California border. As the river drops toward the south and west, entering the Cascade Mountains, it forms a steep canyon within a wider trough comprised of a series of terraces (Figure 2). The Upper Klamath River is that portion of the river above the Cascade Mountain-Klamath Mountain contact. For the purpose of this paper, the study area extends along the Cascade portion of the Upper Klamath River and includes the terraces and adjacent uplands above the river between 640 and 1370 meters (2100 and 4500 feet) (Figure 1).

FIGURE 2. — Upper Klamath River Canyon with Oregon white oaks in foreground.

Climate. — The climate of the Upper Klamath River country is transitional between a continental climate and one strongly modified by the presence of the Pacific Ocean. Since the Upper Klamath River falls within the rain shadow of the Klamath Range to the west, the incoming Pacific storms are usually diminished and precipitation is comparatively low, particularly for a Cascade Range location, averaging between 31.2 - 48.5 cm (12.3 -16.1 in). [2] The most important characteristic of the climate is its unpredictability. A wet year may be followed by a year so dry that it would fit the pattern of the Great Basin. Unusually warm weather in late spring, summer, or early fall may be followed by a hard freeze. The average year in this locale is a summation of mean climatic values around which the actual weather and year-to-year climate oscillates wildly (Figure 3). This intrinsic climatic variability profoundly affects the year-to-year availability of many of the plant food resources found within the study area.

Plant biogeography. — The Klamath River is one of only three rivers which cut entirely through the Cascade-Sierra uplift. The upper reach of the Klamath River, as it flows through the Cascade Mountains, is the most botanically heterogeneous landscape along its entire course. The Cascade Range serves as a semi-permeable biogeographic boundary between the Great Basin Floristic Province and the California Floristic Province. The trough created by the river functions as a corridor connecting portions of the two provinces. The ranges of plants characteristic of

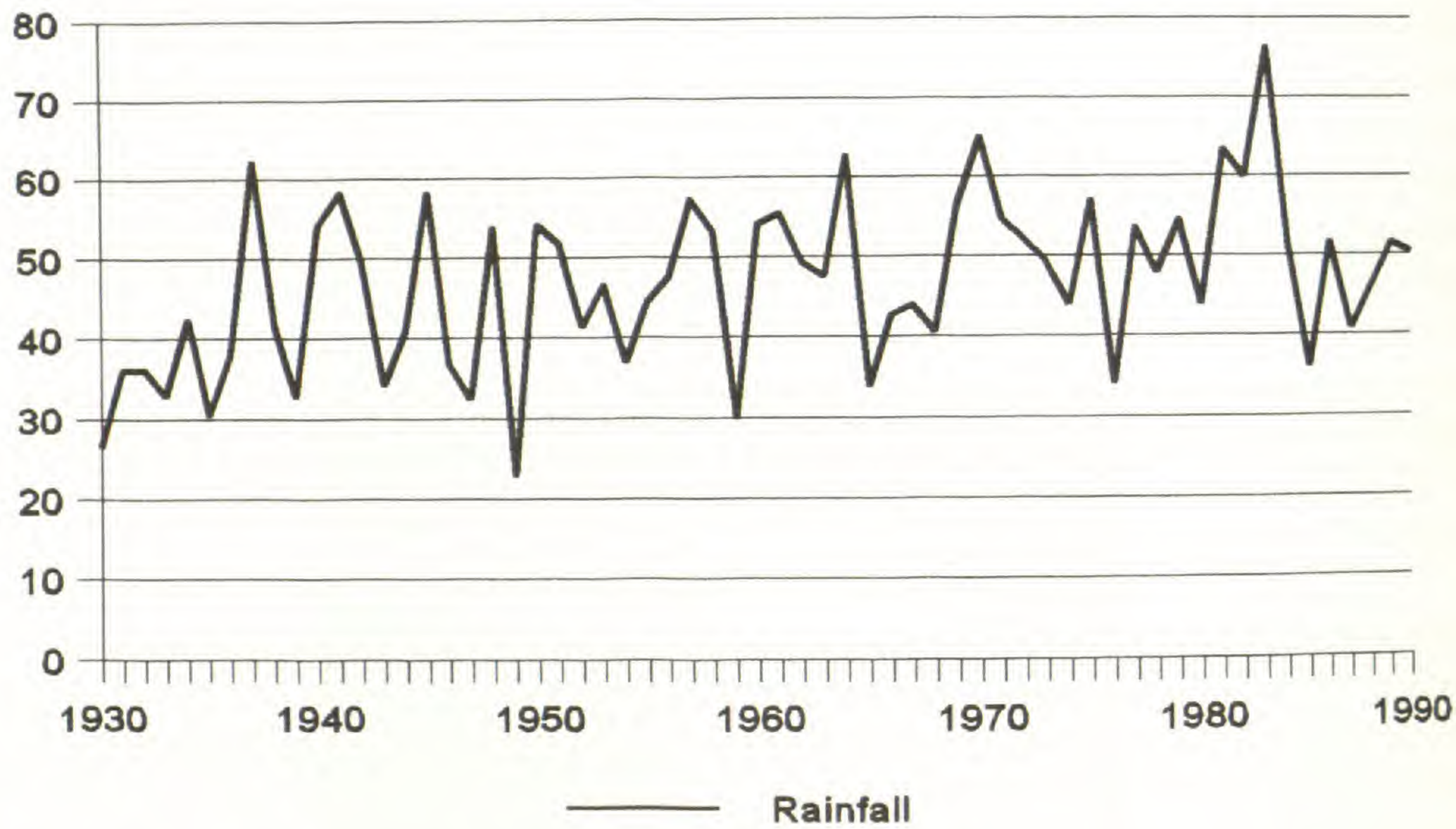


FIGURE 3. — Yearly rainfall in study area (in centimeters).[3]

each region interdigitate throughout the study area, resulting in a large number of species with the potential for ethnobotanical importance. The biogeography of ethnobotanically important species probably had strong cultural implications, influencing the location of resource collection areas, the plant materials chosen for the manufacture of artifacts such as baskets and nets, as well as the primary plants available for sustenance. Trade relationships likely derived from the unequal distribution of culturally important plant resources.

Two ethnobotanically important habitat types, the upland alluvial meadow and the lithosol meadow, are found above the Cascade section of the river, though not commonly within the Klamath Mountain section to the west of the study area. Both of these habitat types form in areas of gentle topography and poor local drainage associated with basalt/andesite rock types weathering into soils with a high proportion of clay particles. These locations are associated with concentrations of ethnobotanically important geophyte species in genera including *Allium, Brodiaea, Camassia, Dichelostema, Lomatium, Perideridia,* and *Triteleia.*

Oak woodlands, which characterize large portions of the California Floristic Province, extend well up the Klamath River. The two oak species which are found along the upper river are California black oak (*Quercus kelloggii* Newb.) and Oregon white oak (*Q. garryana* Hook.), also known as Garry oak. Both species reach their primary upriver range limits on south-facing slopes only a few miles below the point where the river enters the Cascades from the Klamath Basin. Within the California Floristic Province, wherever oak trees are common, acorns have served as a dietary staple. In fact, the abundance of oak trees has been one of the factors used to attempt to retrodict aboriginal population densities within California (Baumhoff 1963:223). Shrubs, which have an especially large number of ethnobotanical uses, are particularly well-represented in the mix. Along and above the rather short stretch of river within the Cascades there are more than 70 shrub species, more than are found within the entire hydrographic Great Basin (Mozingo 1987).

The context of plant food resources. — Plant food resource ranking information is most useful when it is integrated with and contextualized by information about other available resources (Simms 1984:75). Deer (*Odocoileus hemionus hemionus* Rafinesque, *O. hemionus columbianus* Rafinesque) and fish were staple foods on the Upper Klamath River, and are ethnographically regarded as having relatively equal value as resources (Voegelin 1942:58). Although deer are resident year-round, the local dispersed population is supplemented in late fall and winter by a much larger population which migrates into the relatively snow-free elevations of the study area from the surrounding high country (BLM 1990:2-28; map 2-5). Deer are most concentrated and would have been accessible from former village sites during the colder months when caloric demand would have been high and unstored plant food resources would have been generally scarce (Table 1). In winter and spring, deer provide lean meat, with most of their caloric value derived from protein. In May, 1828, as explorer Jedediah Smith worked his way down the Klamath River to the west of the study area, he commented on the poor quality of the spring venison (Morgan 1953:262).

Prehistorically, anadromous fish were the most abundant of the aquatic resources available in the upper Klamath River. While many species of anadromous fish migrated through the upper river, the most important runs were of the spring and fall Chinook salmon (*Onchorynchus tshawytscha* [Walbaum]). The spring Chinook run was the larger and began in April (Holt 1946:310). The spring salmon had a relatively high fat content and so dried and stored poorly. The run of fall Chinook usually began in late September, peaked in October, and was over by early November (Klamath River Basin Fisheries Task Force 1991:4-8). The fall salmon were relatively low in fat content and thus dried and preserved well.

Hunting, fishing, gathering, processing, and storage were coordinated strategies. However, among the Shasta, Modoc, and Klamath peoples, these interdependent strategies were highly gender-specific; the men concentrated on anadromous fish and large game while the women procured plant food resources (Voegelin 1942:62-3). King (1994:197) has suggested that, for nutritional reasons, most prehistoric societies in the temperate zone obtained at least half of their calories from plants. During winter, the period of highest caloric demand, both deer and stored fish furnished low-fat, high-protein diets. Carbohydrates and fats, derived from plants provided by women, supplied nutritional benefits well beyond their caloric value by buffering the deleterious effects of a high protein diet and by increasing the efficiency with which lean animal foods were metabolized (Speth and Spielmann 1983; Leiberman 1987:231-235). There is, therefore, a functional consistency in analyzing plant food resources, even in the absence of particular estimates of nutritional and caloric return values derived from fish and game.

METHODOLOGY

The methodology employed in resource ranking is synthetic, incorporating ethnographic, biogeographic and nutritional data to rank the relative value of plant food resources. Regarding the biogeographic data, it is assumed that the present distribution of species and the availabilities and predictability of harvestable portions reflects characteristics of precontact conditions. Regarding the ethnographic

TABLE 1 — Comparative Importance Ratings and Estimated Caloric Return Rates For Plant Food Resources Found Along the Upper Klamath River.

Species	Part Used	1	2	3	4	5
Staples						
Quercus garryana	acorn	33	11	11	11	8400
Quercus kelloggii	acorn	33	10	11	12	5000
Perideridia oregana	root	32	11	13	8	650
Perideridia bolanderi	root	32	11	13	8	<250
Perideridia gairdneri	root	30	10	13	7	<250
Pinus lambertiana	seeds	30	9	10	11	500
Important						
Madia spp.	seeds	27	9	9	9	350
Sambucus mexicana	fruit	27	8	9	10	2000
Amelanchier utahensis	fruit	27	9	10	8	>250
Perideridia erythrorhiza	root	25	9	8	8	250
Camassia quamash	bulb	25	9	8	8	850
Pinus ponderosa	cambium	25	13	4	8	400
Rhus trilobata	fruit	24	10	6	8	700
Arctostaphylos patula	fruit	24	9	7	8	400
Pinus ponderosa	seeds	24	12	5	7	400
Prunus subcordata	fruit	23	8	6	9	1000
Brodiaea coronaria	corm	23	12	4	7	<250
Sometimes important						
Ribes velutinum	fruit	22	8	6	8	<250
Typha latifolia	rhizome	21	12	2	7	400
Rumex spp.	seeds	21	13	2	6	<250
Prunus virginiana	fruit	21	5	10	6	<250
Vitis californica	fruit	21	9	7	5	<250
Sometimes used						
Cornus glabrata	fruit	20	10	3	7	500
Bryoria sp.	thallus	20	13	2	5	400
Lomatium piperi	tuber	20	8	5	7	>250
Lomatium nudicaule	stem	20	7	6	7	<250
Scirpus acutus	seeds	19	10	1	8	900
Pinus lambertiana	sap	19	9	4	6	<250
Rubus ursinus	fruit	19	4	9	6	<250
Lilium pardalinum	rhizome	18	8	4	6	>250
Darmera peltata	greens	18	7	4	7	<250
Dichelostema capitatum	corm	18	10	4	4	<250
Rosa spp.	fruit	18	10	2	6	<250
Fritillaria recurva	bulb	17	4	6	7	<250
Carex spp.	stem	17	9	3	5	500
Scirpus acutus	rhizome	17	11	1	5	<250
Sparganium sp.	root/stem	17	10	2	5	<250
Balsamorhiza sagittata	seeds	17	9	2	6	<250
Eriogonum spp.	seeds	16	9	1	6	<250
Calochortus macrocarpus	bulb	16	9	2	5	400
Eriogonum nudum	stem	16	7	1	8	<250
Rubus leucodermis	fruit	16	7	3	6	<250

TABLE 1 — (continued)

Species	Part Used	1	2	3	4	5
Sometimes used						
Rubus parviflorus	fruit	16	6	4	6	<250
Descurainia pinnata	seeds	15	7	1	7	350
Mentzelia laevicaulis	seeds	15	7	2	6	400
Pinus contorta	cambium	15	6	2	7	400
Allium spp.	bulb	15	10	1	4	<250
Chrysolepis sempervirens	seeds	15	6	3	6	<250
Leymus cinereus	seeds	15	7	2	6	550
Elymus glaucus	seeds	14	7	1	6	550
Arctostaphylos nevadensis	fruit	14	6	4	4	<250
Fragaria vesca	fruit	14	7	2	5	<250
Heracleum lanatum	stalks	14	7	2	5	<250
Low or infrequent use						
Helianthus bolanderi	seeds	13	6	1	6	300
Grindelia sp.	foliage	13	6	1	6	<250
Phragmites australis	seeds	13	6	2	5	300
Pinus contorta	seeds	13	7	1	5	<250
Prunus emarginata	fruit	12	7	1	4	<250

1 Rating. 2 Availability rating. 3 Ethnographic rating. 4 Nutritional rating. 5 Return rate, cal / hr.

data, it is assumed that the ethnographic record accurately, although incompletely, documents actual resource use. It is further assumed that the Shasta people were the long-term occupants of much of the study area, and that Shasta data should therefore carry the greatest weight. Regarding the nutritional data, it is assumed that optimal foraging models predict and retrodict actual human behavior.

Each plant food species found within the study area and identified within the regional ethnographic record is ranked according to attributes which may have affected its utility (see Appendix 1). These attributes may be divided into three broad categories reflecting the plant's ecological salience, perceptual salience, and potential utility (Turner 1988:272-278). The attributes combine and interact to affect the projected cultural importance of particular species. This projected importance is quantified by assigning numerical values to biogeographic, ethnographic, and nutritional characteristics (Table 1). Numerical values are assigned on the basis of theoretical assumptions pertaining to each of the data categories.

The broad categories of ecological salience, cultural salience, and potential utility are further divided into subcategories. Each broad category has an equal weight, facilitating comparisons between the categorical values. Sub-categories are weighted according to degrees of importance attached to each value. For example, the geographic abundance of a species (eight possible points) is deemed of greater importance than the seasonal availability of a species (four possible points). The weighting of the various categories and sub-categories, while certainly subjective, is based upon extensive fieldwork in the Upper Klamath River region. In other regions, common sense, ground-truthing, desired grain size, and refinement of the rating system method might well dictate different categorical and sub-cat-

egorical values and weightings. The categories and their sub-categories are further explained below (and Appendix 1).

Ecological salience (*biogeographic and temporal availability rating*). — An availability rating should include both the geographic distribution and abundance of the species as well as variations in the abundance of the food product over the course of a year and from year to year. The abundance rating categories are relatively fine-tuned, ranging from "locally rare" to "regionally abundant" and are weighted toward plants which are both abundant and located near known concentrations of Native American occupation sites. The temporal availability rating specifies the window during which a particular food product is both available and palatable. For instance, while some greens are available over most of the growing season, they are only palatable during a short period of time in the early spring. The year-to-year variability is particularly important for highly ranked resources. Oaks, for example, may produce an abundance of acorns one year, while having little or no production the next.

Changes in the plant communities along the Upper Klamath River since the early contact period have resulted in modifications of the distribution and abundance of ethnobotanically important species. Decreased fire frequency, the introduction of non-native plant species, logging, and the establishment of domestic stock grazing initiated most of the changes. Although we will never know all of the details relating to the nature of the precontact environment, we can factor many of the changes into an ethnobotanical analysis. In the Upper Klamath River area, we are relatively close in time and condition to the precontact environment, which remained largely intact until the 1850s. Relevant historic, ethnographic, and ecological clues may be found which pertain to changes in the distribution and abundance of many species. Modifications of biogeographic and availability ratings based on changes since the precontact period are specified in the rating document (Appendix 2) for that particular species.

Perceptual salience (*ethnographic ratings*). — Ethnographic rating subcategories are based primarily on published ethnographies or ethnobotanical works pertaining to the cultures which inhabited the region at the beginning of Euroamerican occupation. Tribes located within and immediately adjacent to the study area are the Penutian-speaking Klamath and Modoc and the Hokan-speaking Shasta (Theodoratus 1991:9-11; Silver 1978:211). Two primary sources of ethnobotanical information pertaining to the Klamath and Modoc tribes, Coville (1898) and Ray (1963), are used to structure the data for these tribes. There is a paucity of ethnobotanical information in the primary ethnographies pertaining to the Shasta (Dixon 1907; Holt 1946; Silver 1978); consequently, data from these sources have been supplemented by information from additional ethnographic and ethnohistoric sources (Merriam MS; Curtis 1924; Kroeber 1925; Voegelin 1942; Olson 1960; LaLande 1981; Mary Carpelan, personal communication, 1998[4]). Ethnobotanical information regarding the Hokan-speaking Karuk (Schenck and Gifford 1952) are included in the analysis since the data are particularly detailed and were obtained from a river-oriented people located along the Klamath River, albeit a distance downstream.

Food resources within the study area not mentioned by the preceding sources were probably culturally or nutritionally insignificant. The numerical ratings are weighted toward Shasta data as the environment of the study area most closely approximates that of traditional Shasta territory, as a portion of the study area contains village sites reported to have been occupied by Shasta people, and as the Shasta maintain strong cultural ties to the region (Figure 4) (Theodoratus 1991:9-13; Betty Hall and Mary Carpelan, Shasta Nation, personal communications, 1993-1998). Processing and storage are cultural practices which extend resource availability and thus increase the plant food's importance. These data are drawn, in most cases, from the ethnographic record, which reflect actual cultural practices rather than potential applications.

Potential utility (nutritional and energetic rating). — The nutritional and energetic ratings complement the ethnographic ratings by providing dietary and economic information pertaining to why particular resources may have been used to a greater or lesser extent. The caloric value of a plant food shows the relative concentration of energy units available per unit of weight from each resource. While plant food resources provide nutritional benefits in addition to calories, the caloric value provides a readily comparable currency for ranking various resources (Smith and Winterhalder 1981:20-21; Simms 1984:46; Kelly 1995:101-102). Most of the nutritional information was obtained from Kuhnlein and Turner (1991), since their coverage includes a large number of species or closely related species found within the study area. Sources of nutritional information for plants more proximate to the study area include Benson *et al* (1973); Farris (1982); Norton *et al* (1984); Simms (1984); and Couture *et al* (1986).[5] In some cases, approximate caloric values were calculated by averaging the values of related species.

Caloric values are useful in rating plants as energy sources. However, they can be misleading when applied to the actual economics of resource use. For instance, very small seeds may have a high caloric value per unit weight but they are often inefficient to gather. Experimental work conducted in the Great Basin by Simms (1984) and Jones and Madsen (1991) clarifies some of the relationships between base caloric values and the caloric return rates which may be expected from particular plant resources. The rating system for the energetic sub-categories described here relies heavily upon these published works as well as upon new experimental data obtained as part of this study.

Plants which contribute important nutrients in addition to calories are given added value. Plants which have more than one food use are given a separate rating for each use. For example, sugar pine (*Pinus lambertiana* Douglas) has edible seeds as well as edible sap crystals. Since each product is obtained by different methods, at different times of year, and each has different caloric values and processing methods, they are rated separately.

While some plant foods such as fresh fruits and greens may be eaten with little or no modification, most plants require varying degrees of processing in order to yield a digestible,

nutritious, and/or storable product. Energy expended in processing these foods may greatly reduce their net caloric value. Simms' experimental data on 24 plant food resources show that on average, about 40% of the value of the hourly caloric

FIGURE 4. — Members of the Shasta Tribe still use the study area for plant gathering and ceremonial purposes. Betty Hall is shown in an *ipos* meadow. Photo courtesy of Mary Carpelan.

return rate was lost in processing (1984:86-87, Table 2). Although it is recognized that many resource-specific variables influence the "cost" of processing, the rating system developed here is based simply upon the type of plant food. Most fresh fruits and greens are considered to have no processing requirements. Fruits which are dried; and large, non-toxic nuts such as sugar pine nuts, are considered to have low processing requirements. Geophytes and medium-to-large seeds such as those of tarweed (*Madia* spp.) are rated as having moderate processing requirements, while acorns and small, chaffy seeds are considered to have high processing requirements. These assignations, while somewhat arbitrary, are generally supported by data in O'Connell and Hawkes (1981:118-119), Simms (1984:86-87, Table 2), Thoms (1989:237-238), Basgall (1987:24), Cane (1987:430), and Wright (1994:244-245). Deviations from these general categories are occasionally made where more applicable processing requirements are documented.

The diet-breadth model simulatess practical economic decisions made by people attempting to maximize energy intake while minimizing energy expenditures. The model, as used by Winterhalder (1981) and Simms (1984), specifies that the resource rendering the greatest caloric return rate per unit of energy expended will be the one preferentially harvested if higher ranked resources become unavailable. The ranking of plant food resources in terms of net caloric values (i.e., return rates) helps to clarify the relative value of a suite of plants within a particular region. The ranking system developed here is area-specific for the Upper Klamath River, relying upon the geographical distribution and abundance of the various species as well as upon potential caloric return rates. For example, although blue elderberries (*Sambucus mexicana* C. Presl (*S. caerulea* Raf.)) have a

potentially high caloric return rate (2,500 cal/hr), they are sparsely distributed within this specific geographical area and so would be relatively inefficient to harvest in quantity. *Ipos* (*Perideridia* spp.),[6] on the other hand, have a lower caloric return rate but are much more widely distributed and available over a longer period of time. Thus they achieve a higher overall importance rating.

The implementation of the rating system is illustrated below, first for a highly rated resource, Oregon white oak, then for the much lower ranked Bolander's sunflower (*Helianthus bolanderi* A. Gray). An understanding of how the rating system operates may be facilitated by referring to the Resource Ranking Criteria (Appendix 1). Documentation of the ratings may be found in Appendix 2.

The biogeographic and temporal availability rating for Oregon white oak acorns is 11 out of a possible 16 points. This rating is obtained by combining the geographic abundance rating (7) with the seasonal availability rating (2) and the variability rating (2). The ethnographic rating (11 out of a possible 16 points) is derived by adding the use rating (4), the importance rating (3), and the processing and storage rating (4). Finally, the nutritional and energetic rating (11 of a possible 16 points) is calculated by combining the caloric value rating (2) with the value for the caloric return rate (4), the processing value (1), the additional food value rating (2), and the economy of scale rating (2). Adding the three larger categories together (11+11+11) yields an overall importance rating of 33 which is the highest numerical value given to a species and equals that of California black oak, which has a slightly different rating profile (see Table 1).

The majority of food plants found within the study area, and identified within the regional ethnographic record, are ranked much lower than the oak species. An example would be Bolander's sunflower, ranked 54th out of ca. 60 species. The biogeographic and temporal availability rating of this sunflower is rated as six of a possible 16 points. Fieldwork indicates that it is uncommon, with very localized populations (2), it is available over a moderate period of time (2), and, since it is an annual, there are frequent fluctuations in its abundance (2). The ethnographic rating is low as well, since closely related species were recorded as having been used only by the Modoc (1). It is not recorded as important or a staple by any of the ethnobotanical works used in this study (0), and it was not recorded as having been dried or stored (0). The total ethnographic rating, then, is only one. The potential utility rating total is seven of a possible 16 points. The caloric value, ca. 365 cal/100g, is fairly high (3), but the caloric return rate is estimated at only ca. 300 cal/hr since local plant populations are scattered and sparse (2). Processing requirements are high (1) since the seeds are small and the heads are very chaffy. The seeds are given an additional food value of (2) due to the presence of fats in addition to carbohydrates and the Economy of Scale rating is (-2). The three larger categories are added together (6+1+6), yielding an importance value of 13. See Table 1 for comparative ranking profiles and estimated return rates.

DISCUSSION

The Upper Klamath River exhibits a great degree of vegetational diversity reflected in a correspondingly large number of plants having the potential for ethnobotanical importance. The great number of ethnobotanically relevant food plants

growing within a small geographic area is due, in part, to the transitional nature and biogeographic complexity of the region. Many plants found within the study area are near the limits of their ranges. Thus they are subject to climatic extremes not experienced by populations located in less peripheral locations. Many species within the study area tend to exhibit small populations, disjunct patterns of distribution, and frequent failures in the production of fruit/seeds. Of the 22 species rated most important in the study area, ten, including the two most highly rated species, *Quercus garryana* and *Q. kelloggii*, exhibit frequent crop failures. If resource predictability strongly mediates a culture's adaptation to an environment (Yellen 1976:265), then the Upper Klamath River area was challenging to its Native inhabitants. Procurement strategies must have been modified frequently in the face of a highly unpredictable and variable resource base, or cultural buffers must have been in place to mediate the effects of the unpredictability of plant food resources.

By far the most important plant food resources, when they were available, were the acorns from two species of oaks. Acorns potentially provided a much higher caloric return rate per unit of energy invested than any other species. Their large component of carbohydrates and fats had the greatest capacity to offset the potential deleterious effects of a diet which would otherwise have been high in animal protein and seasonally low in fat. When acorns are abundant, they may be gathered in quantity and stored at little energetic expense. Although processing costs for acorns are high, an appreciable portion of these costs may be delayed until shortly before they are used and until there is little conflict with the gathering and processing of other plant food resources. The gathering and storage of a large volume of acorns may have been a low investment "insurance policy" against the possibility of a food shortage later in the year.

Variation in acorn availability would have affected the overall plant resource procurement strategy. If acorns were abundant, procurement would have been coordinated with the harvest of many other resources available in the early autumn. If acorns were scarc and thus energetically expensive to gather, scheduling conflicts would likely have occurred between acorn harvest and the harvest of other available plant food resources. Shrewd decisions were probably made regarding the energetic cost effectiveness of focusing on acorns *vis-à-vis* gathering other combinations of resources. Decisions might have been influenced by such factors as resource storability, delayed processing costs, and the "marketability" of resources to be used in trade for acorns as well as upon the energetic logic modeled by optimal foraging theory.

If current observations accurately reflect the precontact situation, there were frequently years in which, for all practical purposes, there was no crop of acorns to be harvested. The situation would be comparable to that further south, near the Cascade - Sierra Nevada border, where people relying on only one oak species (California black oak) recognized the real danger of starvation if that crop failed (Voegelin 1942:177). Options under the circumstance of a small or non-existent acorn crop may have included: 1) accumulation of resources with trade value, such as deer products or obsidian, to facilitate importation of acorns from downriver, 2) intensification of the harvest of other plant food resources, 3) temporary abandonment of the area, or 4) some combination of these responses. There is also the possibility that population levels were maintained below the level at

which the availability of acorns became a nutritionally-limiting factor.

In the event of a shortfall or absence of an acorn crop, the plant food resource within the study area which had the greatest potential for intensification is ***ipos***. This resource, comprised of several species within the study area, meets most of the criteria for an optimal food source. It is consistently available from year to year, it is available during much of the year, it is storable, it was a valued trade commodity, and extensive processing is not essential in order to obtain good nutrition or palatability. *Ipos* was harvested by all cultures within the vicinity of the Upper Klamath River (Voegelin 1942.:177).

Ipos, in this region, was generally gathered in the spring, although there is a record of its having been gathered in late summer or fall as well (Coville 1897:101; Ray 1963:198; Holt 1946:308). The Modoc, lacking access to a large and consistent supply of acorns, devoted approximately one month in the spring to the gathering of *ipos*. Most were processed and stored for use during the coming winter (Ray 1963:198). While the Modoc had a single First Fruit Rite associated with *ipos*, the nearby Atsugewi had three rites associated with this root (Voegelin 1942:57, 176). An indication of how important *ipos* was to the Shasta may be found in the context of a 1960 interview with a Shasta elder, Sargent Sambo, who was at least in his mid-90s at the time. When asked about food, *ipos* was the only plant food which he described in detail:

> "*Epos* are kind of sweet, and we dug them for the winter. You could get lots of them, but they are no more...All those herbs are gone now. The cows have eaten off the tops and the roots have died." (Olson 1960:Appendix B).

The primary limitation to the intensification of this resource would have been its relatively modest initial caloric return rate, at best, one-tenth the return rate from gathering a fair crop of acorns (see Table 1). By way of comparison, much higher return rates are estimated for important geophytes on the nearby Columbia Plateau (Hunn 1981:130-131; Hunn and French 1981:92; Hunn 1990:176). While the estimated high-end caloric return rate for *ipos* in the Upper Klamath River region is 600-800 cal/hr, this rate may be appreciably lowered when *ipos* is dug from dry soil. During years in which autumn rains did not come until September, October, or even November, *ipos* may have been effectively unavailable for harvest. Dry, clay-hardened lithosols effectively thwart efficient procurement efforts. Even today, *ipos* is widely distributed in the alluvial meadows above the Upper Klamath River. Given the likelihood of an even greater abundance of this resource in the past, the limits on procurement would have had more to do with "costs" associated with digging, transporting, and processing these roots than with the species' physical abundance.

With the exception of ***ipos***, few other plant species within the study area have the capacity to support sustained harvest for a long period of time, resulting in the accumulation of a large volume of a storable food product. Those resources which may have supported some intensification include sugar pine, tarweed, elderberry, serviceberry, and, to a lesser extent, camas, three-leaf sumac, and manzanita. None of these, even in combination, has the capacity to equal the calories provided by a modest crop of acorns.

Probably the majority of the remaining plant food species were used occasionally when encountered and might have been nutritionally important at times, but they would not driven the resource procurement strategy. Nevertheless, plants having greens with a high vitamin content such as pestle lomatium (*Lomatium nudicaule* (Pursh) J. Coulter & Rose) or naked-stem eriogonum (*Eriogonum nudum* Benth.) probably were sought out, especially in spring (Holt 1946:309; Schenck and Gifford 1952:385). During times of food shortage, especially in early spring, such resources as the inner bark of ponderosa pine and the thalli of black lichen (*Bryoria* sp.) may have served an important function in providing short-term sustenance until other resources became available. The occasional large crop of Klamath plums (*Prunus subcordata*), grapes (*Vitis californica* Benth.), or chokecherries (*Prunus virginiana* L. var. *demissa* (Nutt.) Torrey) would likely have been factored into the resource procurement strategies for particular years as well. Geophytes such as camas, brodiaeas, and onions (*Allium* spp.) may well have been harvested in conjunction with *ipos*. Most of the remaining food plants either tend to be erratic producers, have restricted distributions, have low caloric return rates, or evidence some combination of these factors (see Appendix 2).

CONCLUSIONS

For a total of more than sixty food plant species reported in regional ethnographic sources and growing in the Upper Klamath River area, resource ranking predicts that only a small number would actually drive the resource procurement behaviors of indigenous peoples. One might suppose that a large number of plant species would comprise a stable resource base upon which indigenous cultures might have depended. In fact, the opposite may be true. Plants near the limits of their ranges often have low population densities, exhibit a high degree of patchiness and have inconsistent fruit production, characteristics which greatly diminish their usefulness and dependability. The generally low caloric return rates matched by low ethnographic ratings for the majority of species probably reflect their minimal contribution to the overall diets of peoples who lived in the vicinity of the Upper Klamath River. For example, resources which would tend to yield less than 250 cal/hr (30 of 58 resources, see Table 1) would have little potential for intensification since effort expended in gathering and processing would not compensate for calories lost in the effort. Nevertheless, enhanced storability may have made resources such as some *ipos* species, tarweed, and other small seed-bearing plants important components of the diet in spite of low return rates (Simms 1984:153-154).

The following resources are those most highly ranked according to the criteria of this study. They are listed in a descending order of importance. Acorns from two species of oaks: Oregon white oak and California black oak, the roots of three species of *ipos* (*Perideridia oregana, P. bolanderi,* and *P. gairdneri*) and the seeds of sugar pine. These species, listed as "staples" in Table 1, are hypothesized to have driven resource procurement behaviors on the Upper Klamath River. The interaction between human nutritional requirements and the plants upon which precontact peoples most depended, those most highly ranked in this study, should be manifested in the archaeological record.

Archaeological applications. — In her synthesis of Upper Klamath River archaeology, Mack (1991:44) called for "an inventory and study of plant resources...in order to understand the potential role of plants within the subsistence pattern of the canyon's past inhabitants." The current study, using biogeographic, ethnographic, and nutritional data, both supplements the archaeological record and suggests archaeological applications. The applicability of resource ranking to the archaeological record depends upon the identification of plants which would have most greatly influenced the location of living sites, task sites, and resource collection areas; and the identification of archaeological signatures for the use of these plants. The following are examples of explanations and testable predictions regarding the local archaeological record, based upon the resource ranking data:

1) While acorns are the most highly ranked plant food resource within the study area, retrodiction from present observations suggests that they were frequently unavailable. Therefore, artifacts associated with acorn processing should not be as strongly represented in the archaeological record of the Upper Klamath area as in regions where the acorn crop is more reliable. Within the California Floristic Province, it is assumed that mortars, pestles and hopper mortar bases are generally associated with acorn processing and that their abundance and relative proportions in a ground stone assemblage can be used as a measure of relative reliance on acorns (Basgall 1987:30). The paucity of mortars and pestles and hopper mortar bases (Mack 1991:10, Table 1, 11) along the Upper Klamath River may be related to the unreliability of the acorn crop reported in this study.

2) A prediction may be made regarding the relative abundance of ground stone tools associated with acorn processing within the study area. The upriver sites, surrounded by oak trees on the very margins of their range, should evidence fewer ground stone tools associated with acorn processing, while the downriver sites, closer to the climatic optimum for the two indigenous species of oaks, should evidence a greater quantity.

3) Resource ranking criteria predict that evidence of acorn procurement activities should be weighted toward locations having an abundance of California black oaks. Black oak acorns, because of their exceptional nutritional value, should have been preferentially harvested when available. The discrete, localized patches of these trees should have been visited more intensively than the more abundant and widespread locations supporting stands of Oregon white oak.

4) Resource ranking retrodicts that geophytes and some seeds would have been dietary staples. Mullers and millingstones are the tools usually associated with the processing of seeds and geophytes. Within the study area, mullers are the most common ground stone tool recovered and both mullers and millingstones are frequently found on the ground surface (Mack 1991:9). The abundance of these artifacts supports the importance attached to these resources by the ranking system. This hypothesis might be further tested by comparing the relative abundance of mullers and millingstones along the Upper Klamath River with their abundance along the middle portion of the Klamath River, where small geophyte and seed resources are far less abundant. Analysis of organic residues on mortars, pestles and other ground stone tools would give a stronger indication of the correspondence between the form and function of these artifacts.

5) The regional ethnographic record indicates that storage pits were used for vegetal foods (Merriam 1905-1929 film 1022: reels 15, 138; Barrett 1910:243; Spier 1930:167). Acorns and geophytes, the predominant foods recorded as being stored underground, are the highest ranked resources in this study. Resource ranking criteria thus predict that evidence of underground food caches should be common in the study area.

6) Within the northern California - southern Oregon region earth ovens were used for both flesh and vegetal foods (Voegelin 1942:61). However, in the Far West generally, the predominant use of earth ovens was for geophyte processing. Although earth ovens are recorded from the nearby Rogue Valley (Prouty 1989), they have not been identified along the Upper Klamath River. In this vicinity, the most highly ranked geophyte, *ipos*, appears to have been processed without the use of earth ovens (1873 interview with Calvin Hall quoted in Neasham 1974:12; Howe 1968:184). Camas and balsamroot (*Balsamorhiza sagittata* (Pursh) Nutt.), which are usually processed in earth ovens, are not abundant and are comparatively low-ranked within the study area. Resource ranking thus predicts that earth ovens used for vegetal food processing would be much less common along the Upper Klamath River than in regions where the predominant geophytes were usually oven-processed, such as in the Pacific Northwest.

7) A general conclusion from the resource ranking data is that plant foods on the Upper Klamath River are patchy, dispersed, and in many cases, unpredictable. Ray, in his description of the neighboring Modoc environment, states that, "The total number of species utilized was impressively large but the physical character of the Modoc habitat was such that many kinds of plants were found only in limited numbers and in widely distributed patches" (1963:197). The Upper Klamath River is of similar character. Patchy, dispersed, and unpredictable resources should foster the mobility characteristic of peoples practicing broad-spectrum resource use. Mobile groups should tend to occupy small settlements, build temporary dwellings requiring minimal energy investment, and construct small storage caches. The archaeological record along the Upper Klamath River tends to validate these hypotheses, although small occupation sites with semi-subterranean houses appeared by at least 1100 B.P. (Mack 1991:39). One factor which may have made this semi-sedentism possible was the amenability of the most highly ranked plant resources to some degree of intensification.

8) According to optimal foraging theory, a relationship exists between the distance people are willing to travel to procure a resource and its caloric return rate (Kelly 1995:133-135). This model predicts that with increasing sedentism, calorically low-ranked plant food resources located at a distance from living sites would be eliminated from the diet. Increased trade associated with semi-sedentism, as evidenced in the archaeological record (Mack 1991:23), might have been one response to the energetic inefficiency of gathering lower-ranked plant foods. Readily obtainable goods such as obsidian and deer hides (Mack, personal communication, 1997)[7] may have been traded for foods more efficiently imported than gathered. Thus, during the late prehistoric period, the evidence of increased trade in the archaeological record may be evidence of the general tenuousness of the region's plant food resource base.

Additional archaeological and ethnobotanical analysis and paleobotanical

analysis should help to clarify the roles of plants in the economy of the past inhabitants of this region. While the present study has relied upon biogeographical data most applicable to the recent past, paleoenvironmental reconstructions should serve to more closely coordinate the earlier archaeological record with the long-term interactions of plants and people along the Upper Klamath River.

ACKNOWLEDGEMENTS

We thank Dr. Joanne Mack, principal investigator for the Upper Klamath River Archaeological Project, for her long-term dedication to research in the study area. We especially thank members of the Shasta Nation, particularly Mary Carpelan, Betty Hall, and Jim Olson for information regarding the plants traditionally used by Shasta people. Thanks also to Mary Carpelan for permission to use her photograph of her mother. Thanks to Jerry Roppe, lead scientist for PacifiCorp, and Tim O'Connor, Roy Wold, Russ Howison, Dan Bevan, Dennis Dummer and, botanist Ed Korpela of PacifiCorp for their project support. The borderland nature of the Upper Klamath River allows us the advantage of access to the expertise and support provided by several administrative areas of the Bureau of Land Management. Thanks to Bill Yehle, Archaeologist, and Lou Whitaker, Botanist, Klamath Falls, Oregon BLM; Bill Cannon, Archaeologist, and Lucile Housley, Ethnobotanist, Lakeview, Oregon BLM; Eric Ritter, Archaeologist, and Joe Molter, Natural Resource Specialist, Redding, California, BLM; and Dr. Kathryn Winthrop, Archaeologist, Fred Tomlins, Resource Specialist and Joan Seevers, Botanist, Medford, Oregon BLM. Thanks to the Earthwatch volunteers who participated in plant gathering trials and to students and crew from Pomona College, especially Eduardo Joval. Particular thanks to Susan Marie Gleason, UC Riverside, for assistance with herbarium specimens. Dr. Frank Lang, Dr. Joanne Mack, Dr. Eugene Hunn, Dr. Nancy Turner, and an anonymous reviewer contributed valuable suggestions on the manuscript.

NOTES

[1] Voucher specimens from this ethnobotanical study on the Upper Klamath River are in Donn Todt's possession. A duplicate set of voucher specimens is curated by the Department of Biology Herbarium at Southern Oregon University, Ashland, Oregon. Botanical nomenclature is according to The Jepson Manual: Higher Plants of California, 1993, Hickman (editor). *Perideridia erythrorhiza* follows Chuang and Constance (1969). Because the Jepson Manual is parsimonious in its use of common names, these are derived from Munz and Keck (1968), Hitchcock and Cronquist (1973), Niehaus and Ripper (1976), as well as Hickman (1993).

[2] The lesser precipitation figure, characterizing the southwestern, low elevation section of the study area, is from Montague, California, located approximately 15 km. south of the river. The greater precipitation figure, characterizing the northwestern, higher elevation portion of the study area, is from Keno, Oregon, located adjacent to the river on the eastern side of the Cascade Range.

[3] Precipitation figures are derived from the vicinity of COPCO Reservoir, in the southwestern portion of the study area. Data courtesy of PacifiCorp, COPCO Division.

[4] Mary Carpelan (Shasta Nation, Quartz Valley Indian Reservation) P.O. Box 773, Yreka CA, 96097.

[5] In Appendix 2, when sources using "dry weight" calculations of calories were referenced, these figures were converted to approximate "fresh weight" values for ease of comparison.

[6] *Ipos* (also spelled *epos, apos, epa, apaws* in the ethnohistoric literature), is both a Native American and an English colloquial name applied to some species within the genus *Perideridia. Yampa,* also having many spellings, is the term used in the Great Basin and Rocky Mountain region for a number of species within this same genus (Todt 1997:252-255).

[7] Dr. Joanne Mack, Department of Anthropology, University of Notre Dame, North Bend IN, 46556.

LITERATURE CITED

AIKENS, C. MELVIN. 1982. Archaeology of the Great Basin: an overview. Pp. 139-155 *in* Man and the Environment in the Great Basin, D. B. Madsen and J. F. O'Connell (editors). Society for American Archaeology Papers #2. Washington, D.C.

AIKENS, C. MELVIN and DENNIS L. JENKINS (editors). 1984. Archaeological Researches in the Northern Great Basin: Fort Rock Archaeology since Cressman. Department of Anthropology and Oregon State Museum of Anthropology, University of Oregon, Eugene.

ANDERSON, ADRIAN and DAVID COLE. 1964. Salt Cave Dam Reservoir Archaeological Project, 1963. Excavations at site SC-1. Interim report to Pacific Power and Light Company (COPCO Division) from the University of Oregon, Eugene.

BASGALL, MARK. 1987. Resource intensification among hunter-gatherers: Acorn economies in prehistoric California. Research in Economic Anthropology 9:212-252.

BARRETT, SAMUEL A. 1910. The Material Culture of the Klamath Lake and Modoc Indians of Northeastern California and Southern Oregon. University of California Publications in American Archaeology and Ethnology 5(4):239-292.

BAUMHOFF, MARTIN. 1963. Ecological determinants of aboriginal California populations. University of California Publications in American Archaeology and Ethnology 49(2):155-236.

BENSON, EVA M., JEAN M. PETERS, MARGRET A. EDWARDS, LOUISE A. HOGAN. 1973. Wild edible plants of the Pacific Northwest. Journal of the American Dietetic Association (Feb.) 62:143-147.

BUREAU OF LAND MANAGEMENT. 1990. Final eligibility and suitability report for the Upper Klamath wild and scenic river study. Lakeview District Office, Lakeview, Oregon.

CANE, SCOTT. 1987. Australian Aboriginal subsistence in the western desert. Human Ecology 15:371-435.

CHUANG, TSAN-IANG and LINCOLN CONSTANCE. 1969. A Systematic Study of *Perideridia*. University of California Publications in Botany 55. University of California Press, Berkeley.

COLE, DAVID L. 1965. Preliminary report: Archaeological excavations at the Keno Development. University of Oregon, Eugene.

COOKE, W.B. 1955. Fungi of Mt. Shasta. Sydowia 9:94-215.

COUTURE, MARILYN D., MARY F. RICKS, and LUCILE HOUSLEY. 1986 Foraging behavior of a contemporary Northern Great Basin Population. Journal of California and Great Basin Anthropology 8(2).

COVILLE, FREDERICK. 1897. Notes on the plants used by the Klamath Indians of Oregon. Contributions from the U.S. National Herbarium 5(2):87-110. Washington, D.C.

CRESSMAN, L. S. and JOHN WELLS. 1962. Salt Caves Dam Reservoir: Interim report on archaeological project, 1961 field season, to Pacific Power and Light (COPCO Division). University of Oregon, Eugene.

CRONQUIST, ARTHUR, ARTHUR H. HOLMGREN, NOEL H. HOLMGREN, JAMES L. REVEAL, and PATRICIA K. HOLMGREN. 1977. Vascular Plants of the Intermountain West, U.S.A. Vol. 6: The Monocotyledons. Columbia University Press, New York.

CURTIS, EDWARD. 1924. The North American Indian. Being a Series of Volumes Picturing and Describing the Indians of the United States, the Dominion of Canada and Alaska. Johnson Reprint Corp., New York.

DAVIS, BARBARA J. and MICHAEL HENDRYX. 1991. Plants and the People: The Ethnobotany of the Karuk Tribe. Siskiyou County Museum, Yreka, California.

DIXON, ROLAND B. 1907. The Shasta. Bulletin of the American Museum of Natural History 7(5):381-498. New York.

———. 1908. Shasta Texts. Edited and revised in 1927 by Lucy S. Freeland. *In* Collection of American Indian Linguistics, Franz Boas (editor).

FARRIS, GLEN J. 1982. Pine nuts as an aboriginal food source in California and Nevada: Some contrasts. Journal of Ethnobiology 2(2):114-122.

GATSCHET, ALBERT S. 1890. The Klamath Indians of Southwestern Oregon. U.S. Government Printing Office, Washington, D. C.

GEHR, ELLIOT. 1985. Section 4.D: Report on historical and archaeological resources, application for license, Salt Caves Hydroelectric Project. Submitted to the Federal Energy Regulatory Commission by the City of Klamath Falls, Oregon.

———. 1986a. Draft application for license, Salt Caves Hydroelectric Project. Submitted to the Federal Energy Regulatory Commission by the City of Klamath Falls, Oregon.

———. 1986b. Congruence of ethnohistoric and archaeological settlement models in the Klamath River Canyon: The Eastern Shasta lost Klamath village of Laik'elmi. Paper presented at the second annual California Indian Conference, University of California, Berkeley.

HANNON, NAN. 1991. Hand to mouth: Plant food resources and prehistoric peoples in Southwest Oregon's Upper Bear Creek Valley. M.A. thesis, Department of Anthropology, Southern Oregon State College. Ashland, Oregon.

HANNON, NAN and RICHARD K. OLMO (editors). 1990. Living with the Land: The Indians of Southwest Oregon. Southern Oregon Historical Society, Medford, Oregon.

HASKIN, LESLIE I. 1934. Wildflowers of the Pacific Coast. Metropolitan Press, Portland, Oregon.

HEIZER, ROBERT F. and ALBERT B. ELSASSER. 1980. The Natural World of the California Indian. University of California Press, Berkeley.

HELFRICH, DEVERE. 1966. Klamath Echoes 3:1-84. Klamath County Historical Society, Klamath Falls, Oregon.

HICKMAN, JAMES C. (editor). 1993. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley.

HITCHCOCK, C. LEO and ARTHUR CRONQUIST. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle.

HOLT, CATHERINE. 1946. Shasta ethnography. University of California Anthropological Records 3(4):299-249.

HOWE, CARROL B. 1968. Ancient Tribes of the Klamath Country. Binfords and Mort, Portland, Oregon.

HUNN, EUGENE S. 1981. On the relative contribution of men and women to subsistence among hunter-gatherers of the Columbia Plateau: A comparison with *Ethnographic Atlas* summaries. Journal of Ethnobiology 1(1):124-134.

———. 1990. Nch'i-wána "The Big River" Mid-Columbia Indians and Their Land. University of Washington Press, Seattle.

———.and DAVID H. FRENCH. 1981. Lomatium: A key resource for Columbia Plateau native subsistence. Northwest Science 55(2):87-94.

JENSEN, PETER. 1987. Additional information supporting: Report on historic and archaeological resources for the Salt Caves Hydroelectric Project, Klamath Falls, Oregon. Prepared by Jensen and Associates Archaeological Consultations and Research, Chico, California for the City of Klamath Falls, Oregon.

——— and A.E. FARBER. 1982. Archaeological data recovery program at CA-SIS-342. Report on file, California Department of Transportation, Redding.

JONES, KEVIN T. and DAVID B. MADSEN. 1991. Further experiments in native food procurement in Utah. Utah Archaeology 1991:68-78. Utah Professional Archaeological Council and Utah Division of State History, Salt Lake City.

KELLY, ROBERT L. 1995. The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways. Smithsonian Institution Press, Washington.

KING, FRANCIS B. 1994. Interpreting wild plant foods in the archaeological record. Pp. 185-209 *in* Eating on the Wild Side, Nina L. Etkin (editor). University of Arizona Press, Tucson.

KLAMATH RIVER BASIN FISHERIES TASK FORCE. 1991. Long range plan for the Klamath River Basin Conservation Area fishery restoration program. Prepared with the assistance of William M. Kier Associates. U.S. Fish and Wildlife Service, Klamath River Fishery Resource Office, Yreka, California.

KROEBER, ALFRED L. 1925. Handbook of the Indians of California. Bureau of American Ethnology Bulletin 78, Washington, D. C.

KUHNLEIN, HARRIET V. and NANCY J. TURNER. 1991. Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany and Use. Gordon and Breach Science Publishers, Philadelphia.

LALANDE, JEFF. 1987. First Over the Siskiyous: Peter Skene Ogden's 1826-1827 Journey through the Oregon-California Borderlands. Oregon Historical Society Press, Portland.

LIEBERMAN, LESLIE S. 1987. Biocultural consequences of animals versus plants as sources of fats, proteins, and other nutrients. Pp. 225-258 *in* Food and Evolution: Toward a Theory of Human Food Habits. Marvin Harris and Eric B. Ross (editors). Temple University Press, Phhiladelphia.

LEONHARDY, F.C. 1961. The cultural position of the Iron-Gate site. M.A. thesis, Department of Anthropology, University of Oregon, Eugene.

MACK, JOANNE M. 1983. Archaeological investigations in the Salt Caves Locality: Subsistence uniformity along the Klamath River, Oregon. University of Oregon Anthropology Papers No. 29. Eugene.

———. 1990. Archaeology of the Upper Klamath River. Pp 10-25 *in* Living with the Land: The Indians of Southwest Oregon. Nan Hannon and Richard K. Olmo (editors). Southern Oregon Historical Society, Medford, Oregon.

———. 1991. Klamath River Canyon prehistory. Pp. 1-110 *in* Klamath River Canyon Prehistory and Ethnology Richard C. Hanes (editor). Cultural Resource Series 8, Bureau of Land Management, Oregon State Office.

MERRIAM, C. HART. 1905-1929. Shasta ethnographic notes, including word lists. Unpublished notes in the Department of Anthropology, University of California, Berkeley. Microfilm available Bancroft Library, Berkeley: BANC film 1022, reels 15, 138.

———. 1907. Field check lists, Pacific Coast region: United States Department of Agriculture, biological survey: Schedule 20. Manuscript in Department of Anthropology, University of California Archaeological Survey, Berkeley.

MORGAN, DALE L. 1953 Jedediah Smith and the Opening of the West. Bobbs-Merrill. Indianapolis.

MOZINGO, HUGH N. 1987 Shrubs of the Great Basin: a Natural History. University of Nevada Press, Reno.

MUNZ, PHILIP A. and DAVID D. KECK. 1968. A California Flora and Supplement. University of California Press, Berkeley.

NASLUND, HOWARD RICHARD. 1977. Geology of the Hyatt Reservoir and Surveyor Mt. Quadrangles, Oregon. Master's thesis, Department of Geology, University of Oregon, Eugene.

NEASHAM, ERNEST R. 1974. Fall River Valley: An Examination of Historical Sources. California Indians, Vol. III. Garland Publishing, New York.

NEWMAN, THOMAS M. and L.S. CRESSMAN. 1959. Final report on archaeological salvage program in the Big Bend Project of COPCO on the Klamath River, Oregon. Report to the California-Oregon Power Company by the Museum of Natural History, University of Oregon, Eugene.

NIEHAUS, THEODORE F. and CHARLES L. RIPPER. 1976. A Field Guide to Pacific States Wildflowers. Houghton Mifflin, Boston.

NORTON, H. H., E. S. HUNN, C. S. MARTINSEN, and P. B. KEELY. 1984. Vegetable food products of the foraging economies of the Pacific Northwest. Ecology of Food and Nutrition 14:219-228.

O'CONNELL, J. F. and KRISTIN HAWKES. 1981. Alyawara plant use and optimal foraging theory. Pp. 99-125 *in* Hunter-Gatherer Foraging Strategies. Bruce Winterhalder and Eric Alden Smith (editors). University of Chicago Press, Chicago.

OLIVER, WILLIAM W. and RUSSELL RYKER. 1990-1991. Ponderosa pine. Pp. 413-434 *in* Silvics of North America, Russell M. Burns and Barbara H. Honkala (editors). United States Forest Service, U.S. Department of Agriculture, Washington, D.C.

OLSON, GEORGE. 1960. The Shasta. Paper on file at Southern Oregon Historical Society, Medford, Oregon.

PHILLIPS, OLIVER and ALWYN H. GENTRY. 1993. The useful plants of Tambopata, Peru I. Statistical hypothesis tests with a new quantitative technique. Economic Botany 47(1):15-32.

PRANCE, G. T., W. BALEE, B. M. BOOM and R. L. CARNEIRO. 1987. Quantative ethnobotany and the case for conservation in Amazonia. Conservation Biology 1:296-310.

PROUTY, GUY LEE. 1995. Roots and tubers: Prehistoric plant use, settlement and subsistence intensification, and storage in the Fort Rock Basin, northern Great Basin, Oregon. Ph.D.dissertation, Department of Anthropology, University of Oregon, Eugene.

RAY, VERNE F. 1963. Primitive Pragmatists: The Modoc Indians of Northern California. American Ethnological Society Monograph 38.

SCHENCK, SARA M. and E.W. GIFFORD. 1952. Karok ethnobotany. Anthropological Records 13(6):377-392.

SILVER, SHIRLEY. 1978. Shastan peoples. Pp. 211-224 *in* California, Volume 8, Handbook of North American Indians, Robert F. Heizer (volume editor). Smithsonian Institution, Washington, D.C.

SIMMS, STEVEN R. 1984. Aboriginal Great Basin foraging strategies: An evolutionary analysis. Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City.

SINCLAIR, WAYNE A., HOWARD H. LYON, and WARREN T. JOHNSON. 1987. Diseases of Trees and Shrubs. Cornell University Press, Ithaca, New York.

SMITH, ERIC ALDEN and BRUCE WINTERHALDER. 1981. New perspectives on hunter-gatherer socioecology. Pp. 1-35 *in* Hunter-Gatherer Foraging Strategies. Bruce Winterhalder and Eric Alden Smith (editors). University of Chicago Press, Chicago.

SPETH, JOHN D. and K. A. SPIELMANN. Energy source, protein metabolism, and hunter-gatherer subsistence strategies. Journal of Anthropological Archaeology 2:1-31.

SPIER, LESLIE. 1930. Klamath Ethnography. Anthropological Papers in American Archaeology and Ethnology 30. University of California, Berkeley.

THEODORATUS, DOROTHY J., MYRELEEN M. ASHMAN, HELEN McCARTHY, and DONNA L. GENETTI. 1991. Klamath River Canyon ethnology study. Pp. 1-31 *in* Klamath River Canyon Prehistory and Ethnology. Richard C. Hanes (editor). Cultural Resource Series 8. Prepared by Theodoratus Cultural Research for Bureau of Land Management, Lakeview District, Lakeview, Oregon.

THOMS, ALSTON B. 1989. The northern roots of hunter-gatherer intensification: Camas and the Pacific Northwest. Ph.D. dissertation, Department of Anthropology, Washington State University, Pullman.

TODT, DONN L. 1997. Cross-cultural folk classifications of ethnobotanically-important geophytes in Southern Oregon and Northern California. Journal of California and Great Basin Anthropology 19(2):250-259.

TURNER, NANCY J. 1988. The importance of a rose: Evaluating the cultural significance of plants in Thompson and Lillooet Interior Salish. American Anthropologist 90:272-290.

UNITED STATES DEPARTMENT OF AGRICULTURE. 1941. Climate and Man: Yearbook of Agriculture. United States Department of Agriculture, United States Government Printing Office, Washington, D.C.

VOEGELIN, ERMINIE WHEELER. 1942. Culture element distributions, XX: Northeastern California. University of California Anthropological Records 7(2):47-252. Berkeley.

WILLIAMS, HOWEL. 1949. Geology of the Macdoel Quadrangle. State of California Department of Natural Resources, Division of Mines, San Francisco.

WRIGHT, KATHERINE I. 1994. Ground-stone tools and hunter-gatherer subsistence in Southwest Asia: Implications for the transition to farming. American Antiquity 59(2):238-263.

YELLEN, JOHN E. 1976. Long-term hunter-gatherer adaptations to desert environments: A biogeographical perspective. World Archaeology 8(3):262-274.

APPENDIX 1

Resource Ranking Criteria

I. Ecological Salience (Biogeographic and Temporal Availability Rating)

A. Geographic Abundance

+1 Isolated individuals or isolated small stands
+2 Uncommon and localized populations
+3 Small populations within restricted environments
+4 Scattered individuals or stands throughout a significant portion of the study area
+5 Common within localized portions of the study area, usually well removed from the river
+6 Common within localized portions of the study area near river
+7 Common within a significantly large portion of the study area
+8 Abundant throughout much of the study area

B. Seasonal Availability (by month)

+1 Available over a short period of time (< 1 month)
+2 Available over a moderate period of time (1-3 months)
+3 Available over a long period of time (3-6 months)
+4 Available over a good portion of the year (>6 months)

C. Year-to-year Variability (Predictability)

+1 Plant seldom bears harvestable portions
+2 Frequent fluctuations in the abundance of harvestable portions
+3 Occasional fluctuations in the abundance of harvestable portions
+4 Consistently bears harvestable portions

II. Perceptual Salience (Ethnographic Rating)
- A. Use by tribes recorded in indexed sources
  - +0 Not reported as used in the indexed sources
  - +1 Use by one tribe exclusive of Shasta
  - +2 Use by two to three tribes exclusive of Shasta
  - +3 Use by Shasta but not other indexed tribes
  - +4 Use by Shasta plus one other tribe
  - +5 Use by Shasta plus two other tribes
  - +6 Use by Shasta plus three other tribes
- B. Rated as Important or a Staple by Tribes in Vicinity
  - +0 Not important to the indexed tribes
  - +1 Important or staple by one tribe exclusive of Shasta
  - +2 Important or staple by two-three tribes exclusive of Shasta
  - +3 Important or staple by Shasta but not other tribes
  - +4 Important or staple by Shasta plus one other tribe
  - +5 Important or staple by Shasta plus two other tribes
  - +6 Important or staple by Shasta plus three other tribes
- C. Processing and Storage
  - +0 Not recorded as being dried/stored by the indexed tribes
  - +1 Recorded as being dried/stored by at least one tribe exclusive of Shasta
  - +2 Recorded as being dried/stored by at least two tribes exclusive of Shasta
  - +3 Recorded as being dried/stored by Shasta
  - +4 Recorded as being dried/stored by Shasta and at least one other tribe

III. Potential Utility (Nutritional and Energetic Rating)
- A. Caloric value per 100 grams
  - +1 <100 cal/100 grams
  - +2 100-300 cal/100 grams
  - +3 300-500 cal/100 grams
  - +4 500+ cal/100 grams
- B. Caloric return rate in calories per hour
  - +1 <250 cal/hr
  - +2 250-1000 cal/hr
  - +3 1000-5000 cal/hr
  - +4 5000+ cal/hr
- C. Processing requirements
  - +1 High processing requirements (acorns and small, chaffy seeds)
  - +2 Moderate processing requirements (roots, seeds)
  - +3 Low processing requirements (dried fruit)
  - +4 No processing requirements (fresh fruit, greens)
- D. Additional Food Value
  - +1 Provides primarily carbohydrates
  - +2 Provides carbohydrates plus a significant portion of at least one other nutrient in short supply
- E. Economy of Scale
  - -2 Usually gathered/consumed in very small portions (most foliage)
  - -1 Usually gathered/consumed in small portions (uncommon fruit, etc.)
  - 0 Quantity not known or not available
  - +1 Usually gathered/consumed in moderate portions when available
  - +2 Usually gathered/consumed in large portions when available

APPENDIX 2. — Plant Food Resource Evaluation and Documentation (use in conjunction with Appendix 1)

Quercus garryana (Oregon white oak: acorns) Total = 33
Biogeographic and Temporal Availability Rating: A (+7), **B** (+2) Sept.- Oct., **C** (+2)
Ethnographic Rating: A (+4) Shasta: (Dixon 1907:243); (Holt 1946:308). Karuk: (Schenck and Gifford 1952:382). **B** (+3) Shasta: (LaLande 1987:40). **C** (+4) Shasta: (LaLande 1987:40). Note: Ethnohistoric sources often don't differentiate between oak species. It is assumed that white oak acorns were stored.
Nutritional and Energetic Rating: A (+2) 270 cal / 100 g. Based on an average of four oak spp. (Kuhnlein and Turner 1991:435-436, Table 5A). **B** (+4) 8,370 cal / hr. (Hannon 1991:93). **C** (+1) **D** (+2), **E** (+2) Note: The actual economy of scale would be a multiple of this figure.

Quercus kelloggii (California black oak: acorns) Total = 33
Biogeographic and Temporal Availability Rating: A (+6), **B** (+2) Sept.- Oct., **C** (+2)
Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1958:382). Note: Not used by Klamath or Modoc (Voegelin 1942:177). **B** (+3) Shasta: (LaLande 1987:40) **C** (+4) Shasta: (Kroeber 1926:293; LaLande 1987:40). Karuk: (Schenck and Gifford 1958:382). Note: Storage of black oak acorns not specifically mentioned for the Karuk but they were likely stored in the same fashion as other acorns.
Nutritional and Energetic Rating: A (+3) 400 cal / 100 g. Based on an average of four oak spp. (Kuhnlein and Turner 1991: 435-435, Table 5A), but given added value because of the particularly high fat content of *Q. kelloggii* acorns. **B** (+4) Assigned a lower return rate than *Q. garryana,* since they don't mast as heavily in this area. **C** (+1), **D** (+2), **E** (+2)

Perideridia oregana (*ipos, yampa*: root) Total = 32
Biogeographic and Temporal Availability Rating: A (+5) Note: Increased from +4 to +5 due to a likely decrease in abundance since the contact period. **B** (+3) April-June, Sept.- Nov., **C** (+3)
Ethnographic Rating: A (+5) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:213). Klamath: (Coville 1897:101). **B** (+4) Shasta: Several lines of evidence point to *ipos* being regarded as a staple (Voegelin 1942:58; Holt 1946:308; Olson 1960:Appendix B). Modoc: (Ray 1963:197). **C** (+4) Shasta: (Holt 1946:308). Modoc: (Ray 1963:198). Klamath: (Coville 1897:101). Note: *Perideridia* spp. lumped together in Ethnographic Ratings.
Nutritional and Energetic Rating: A (+2) 117 cal / 100 g. (Norton *et al* 1984:223-4 Table I). **B** (+2) 650 cal / hr. Based on harvest data in Ray (1963:198). **C** (+2) **D** (+1) **E** (+1)

Perideridia bolanderi (*ipos, yampa:* root) Total = 32
Biogeographic and Temporal Availability Rating: A (+5) Adjusted for likely decrease in abundance since contact. **B** (+3) April- June, Sept.- Nov. **C** (+3)
Ethnographic Rating: A (+5) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:198). Klamath: (Coville 1897:101). Note: *Perideridia* spp. lumped together in Ethnographic Ratings. **B** (+4) Shasta: (Voegelin 1942:58; Holt 1946:308: Olson 1960: Appendix B). See *P. oregana.* **C** (+4) See *P. oregana.*
Nutritional and Energetic Rating: A (+2) 117 cal / 100 g. (Based on *P. gairdneri.* Norton *et al* 1984:223-4 Table I) **B** (+1) < 250 cal / hr. Based on harvest trials within study area 1994-95. **C** (+2) **D** (+2) **E** (+1)

Perideridia gairdneri (*ipos, yampa*: root) Total = 30
Biogeographic and Temporal Availability rating: A (+4) Rating increased from +3 to +4 due to the likelihood of its decreased abundance since contact. **B** (+3) April- June, Sept.- Nov. **C** (+3)

Ethnographic Rating: A (+6) Shasta, Modoc, Klamath: See *P. oregana*. Karuk: (Schenck and Gifford 1952:387). **B** (+3) Shasta: Several lines of evidence point to *ipos* of various spp. being regarded as a staple (Voegelin, 1942:58; Holt 1946 1946:308; Olson 1960: Appendix B). Modoc, Klamath, Karuk: Not common enough to be considered a staple. **C** (+4) Shasta: (Holt 1946:308). Modoc: (Ray 1963:198). Klamath: (Coville 1897:101). Karuk: Storage not indicated (Schenck and Gifford, 1952:387).

Nutritional and Energetic Rating: A (+2) 117 cal / 100 g (Norton *et al* 1984:223-4) **B** (+1) <250 cal / hr. Based upon harvest trials within the study area 1994-95. **C** (+2) **D** (+1) **E** (+1)

Pinus lambertiana (sugar pine: seeds) Total=30

Biogeographic and Temporal Availability Rating: A (+5) Based on historic evidence (LaLande 1987:35; Klamath Echoes 1966:45). **B** (+1) Sept. **C** (+3)

Ethnographic Rating: A (+6) Shasta: (Dixon 1907:424-427; Kroeber 1926:294; Holt 1946:308). Modoc: (Ray 1963:218). Klamath: Coville (1897:88). Karuk: (Schenck and Gifford 1952:378). **B** (+0) **C** (+4) Shasta: (Krober 1926:294; Holt 1946:308). Karuk: (Schenck and Gifford 1952:378).

Nutritional and Energetic Rating: A (+4) 594 cal / 100 g. (Farris 1982:119 Table II). **B** (+2) Based on an estimate of 500 cal / hr. **C** (+2) Karuk: (Schenck and Giffford 1952:378). **D** (+2) fat **E** (+1)

Madia spp. (tarweed: seeds) Total=27

Biogeographic and Temporal Availability Rating: A (+4) **B** (+2) Sept.- Oct. **C** (+3) An annual subject to population fluctuations.

Ethnographic Rating: A (+5) Shasta: (Curtis 1924:lll). Modoc: (Ray 1963:199). Klamath: (Coville 1897:106). Karuk: Recognized as a food plant (Schenck and Gifford 1952:387). **B** (+0) **C** (+4) Extrapolating from the ethnographic record for western North America, it is suggested that intensively harvested small seeds were stored by the people who gathered them.

Nutritional and Energetic Rating: A (+4) 580 cal / 100 g. Derived from the value of *Helianthus annuus* L. (Kuhnlein and Turner 1991 428, Table 5A). **B** (+2) 350 cal / hr. Derived from limited gathering trials by Todt in the nearby Rogue Valley, Oregon. **C** (+2) **D** (+1) **E** (+0)

Sambucus mexicana (blue elderberry: fruit) Total=27

Biogeographic and Temporal Availability Rating: A (+3) **B** (+2) Aug.- Oct. **C** (+3) Fairly consistent at higher elevations; frequent fluctuations at lower elevations.

Ethnographic Rating: A (+6) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:199-200). Klamath: (Coville 1897:104). Karuk: (Schenck and Gifford 1952:389). **B** (+0) **C** (+3) Shasta: (Dixon 1907:424).

Nutritional and Energetic Rating: A (+1) 52 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+3) 2000 cal / hr. Based on an average of four gathering trials conducted by Todt in the Keno, OR vicinity, 1992-1995. **C** (+4) For fresh fruit. **D** (+2) Vitamin C (Kuhnlein and Turner 1991:460 Table 6A). **E** (+0)

Amelanchier utahensis (Utah serviceberry: fruit) Total=27

Biogeographic and Temporal Availability Rating: A (+5) **B** (+2) Aug.- Oct) **C** (+2) A fungus affects serviceberries in this vicinity, often rendering a large proportion of the fruit unpalatable. Value increased from +1 to +2 since the fungus may have been less common in the precontact period.

Ethnographic Rating A (+6) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:200). Klamath: (Coville 1897:97). Karuk: (Schenck and Gifford 1952:385). **B** (+0) Culturally important to Shasta, who served them to guests (Holt 1946:308). (+4) Shasta: (Dixon 1907:424; Holt 1946:308). Klamath: (Coville 1891:97). Karuk: (Schenck and Gifford 1952:385).

Nutritional and Energetic Rating: A (+1) 90 cal / 100 g. (Kuhnlein and Turner, 1991:442 Table 6A). **B** (+2) >250 cal / hr. Derived from gathering trials conducted by Todt near Keno, OR 1992-1995. Fungus affected a large portion of the fruit in all years. Value increased from +1 to +2. See above. **C** (+3) For dried fruit. **D** (+2) vitamin A (*Ibid.*) **E** (+0)

Perideridia erythrorhiza (*ipos, yampa*: roots) Total=25

Biogeographic and Temporal Availability Rating: A (+3) Biogeographic abundance increased from +2 to +3 due to the likelihood of decreased abundance through the historic period. **B** (+3) April- June, Sept.- Nov. **C** (+3) Fluctuations probably due to weather and predation by burrowing rodents.

Ethnographic Rating: A (+5) Probably occasionally used by the Shasta, Modoc and Klamath. *Perideridia* spp. not differentiated. **B** (+0) Due to restricted habitat. **C** (+3) Shasta: (Holt 1946:308) For *ipos* generally. Species perhaps more common in this area than elsewhere.

Nutritional and Energetic Rating: A (+2) 117 cal/ 100 g. Based upon *P. gairdneri* (Norton *et al* 1984:223-4 Table I) **B** (+2) Estimated. **C** (+3) < 250 cal / hr. Estimated. **D** (+1) **E** (+0)

Camassia quamash (camas: bulb) Total=25

Biogeographic and Temporal Availability Rating: A (+3) **B** (+3) Mar.- June, Sept.- Nov. **C** (+3)

Ethnographic Rating: A (+5) Shasta: (Dixon 1907:424) Modoc: (Ray 1963:198) Klamath: (Coville 1897:93). **B** (+1)? Possibly Modoc: (Ray 1963:198). **C** (+2) Modoc: (*Ibid.*) Klamath: (Coville 1897:93).

Nutritional and Energetic Rating: A (+2) 150 cal / 100 g. (Couture et. al. 1986:158 Table 3) 113 cal / 100 g (Benson *et al* 1973:143). **B** (+2) 850 cal / hr. An estimate based on observed low population densities and small sizes of bulbs. **C** (+2) Cooking required for good nutritional value. **D** (+1) **E** (+1)

Pinus ponderosa (ponderosa pine: inner bark) Total=25

Biogeographic and Temporal Availability Rating: A (+8) **B** (+1) May (Coville 1897:89) Probably earlier at lower elevations along the river. **C** (+4)

Ethnographic Rating: A (+4) Shasta: (Dixon 1907:424; Curtis 1924:111). Modoc: Not specifically mentioned in Ray (1963), but likely used. Klamath: (Coville 1891:89). **B** (+0) Though may have been important during times of food scarcity. **C** (+0)

Nutritional Rating: A (+2) 100 cal / 100 g. From data pertaining to *Tsuga heterophylla* (Raf.) Sarg. (Kuhnlein and Turner 1994:346 Table 1A). **B** (+2) 400 cal / hr. Estimated. **C** (+4) Eaten uncooked (Curtis 1924:111). **D** (+1)? **E** (-1)

Rhus trilobata (three-leaf sumac: fruit/seeds) Total=24

Biogeographic and Temporal Availability Rating: A (+4) Western section of study area at low elevations. **B** (+3) Aug.- Nov. **C** (+3)

Ethnographic Rating: A (+3) Shasta: (Dixon 1907:424; Holt 1946:308). **B** (+0) **C** (+3) (Dixon 1907:424).

Nutritional and Energetic Rating: A (+1) 100 cal / 100 g. Value assigned according to *Rhus glabra* L. (Kuhnlein and Turner 1991:452 Table 6A). **B** (+2) <1000 cal / hr. Based upon gathering trials conducted by Todt in 1996. **C** (+2) For dried, pounded. **D** (+2) vitamin A (*Ibid.*) **E** (+1)

Arctostaphylos patula (greenleaf manzanita: fruit/seed) Total=24

Biogeographic and Temporal Availability Rating: A (+5) **B** (+2) Sept.-Oct. **C** (+2)

Ethnographic Rating: A (+5) Shasta: (Dixon 1907:243-244). Modoc: (Ray 1963:212, 218 Appendix II). Klamath: (Coville 1897:102). Karuk: (Schenck and Gifford 1952:388) Note: Dixon (1907) and Ray (1963) reference species other than *A. patula*. **B** (+1) Karuk: (Davis and Hendryx 1991:149). **C** (+1) Karuk: (Schenck and Gifford 1952:388).

Nutritional and Energetic Rating: A (+1) 90 cal / 100 g. Data from *A. uva-ursi* (L.) Sprengel (Kuhnlein and Turner 1991:442 Table XX) **B** (+2) 400 cal / hr. Estimated. **C** (+2) Processing involved pounding and winnowing. **D** (+2) Vit. A (*Ibid.*) **E** (+1)

Pinus ponderosa (ponderosa pine: seeds) Total=24

Biogeographic and Temporal Availability Rating: A (+8) **B** (+2) Sept.- Oct. **C** (+2) (Oliver and Ryker 1990-91:416).

Ethnographic Rating: A (+4) Shasta: (Holt 1946:308) Modoc: (Ray 1963:199) Possibly a reference to *P. lambertiana.* **B** (+0) **C** (+1)? Modoc: (Ray 1963:199).

Nutritional and Energetic Rating: A (+3) 450 cal / 100 g. Estimated from data pertaining to *P. edulus* Engelm.(Kuhnlein and Turner 1991:434 Table 5A). **B** (+2) 400 cal / hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Prunus subcordata (Klamath plum: fruit) Total=23

Biogeographic and Temporal Availability Rating: A (+5) **B** (+1) Sept. **C** (+2) Fruit often affected by pathogens in Upper Klamath River vicinity.

Ethnographic Rating: A (+5) Shasta: (Holt 1946:308). Modoc: (Ray 1963:200). Klamath: (Coville 1897:99). **B** (+0) **C** (+1) Karuk: (Schenck and Gifford 1952:384-385).

Nutritional and Energetic Rating: A (+1) 47 cal / 100 g. Based upon data from "Damson" plum (Kuhnlein and Turner 1991:450 Table 6A). **B** (+2) 1000 cal / hr. Based on gathering trials conducted by Todt in the Keno, OR vicinity, 1992-1995. **C** (+4) For fresh fruit. However Shasta cooked fruit as well (Holt 1946:308). **D** (+1)? Possibly vitamin A and C (Kuhnlein and Turner 1991:450 Table 6. **A**) **E** (+1)

Brodiaea coronaria (harvest brodiaea: corm) Total=23

Biogeographic and Temporal Availability Rating: A (+5) **B** (+3) April- June, Sept.- Nov. **C** (+4)

Ethnographic Rating: A (+4) Shasta: (Holt 1907:308). Karuk: (Schenck and Gifford 1952:380). Plants not identified to species in the Shasta ethnographic record. **B** (+0) **C** (+0) Note: *Triteleia hyacinthina* (Lindley) E. Green (white brodiaea) is fairly common within the study area and may have been used as well.

Nutritional and Energetic Rating: A (+2) 100 cal / 100 g. is an average value for starchy geophytes. **B** (+1) <250 cal / hr. Estimated. Populations often sparse. **C** (+2) (Schenck and Gifford 1952:380). **D** (+1) **E** (+1)

Ribes velutinum E. Greene (plateau gooseberry: fruit) Total=22

Biogeographic and Temporal Availability Rating: A (+4) This is the most common of eight *Ribes* spp. growing within the study area. **B** (+2) July-Aug. **C** (+2) Years of low productivity show a correlation with drought years.

Ethnographic Rating: A (+5) *Ribes* spp. often not well differentiated in the ethnographic record.

Shasta: (Holt 1946:308). Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:97). Karuk: Beyond expected range of *R. velutinum.* **B** (+0) **C** (+1) Generally not preserved (Holt 1946:308; Coville 1897:97; Schenck and Gifford 1952:389).

Nutritional and Energetic Rating: A (+1) 52 cal / 100 g. Based upon *Ribes* spp. (gooseberries) (Norton *et al* 1984:223-4 Table I) **B** (+1) 110 cal / hr. An average from three years of gathering trials conducted by Todt near Keno, Oregon. **C** (+4) **D** (+2) vitamin C for some *Ribes* spp. (Kuhnlein and Turner 1991:452-454 Table 6A) **E** (+0)

Typha latifolia L. (cattail: rhizome) Total=21

Biogeographic and Temporal Availability Rating: A (+6) **B** (+2) Aug., Sept., Oct. (Simms 1984:257 Appendix) **C** (+4)

Ethnographic Rating: A (+2) Modoc: (Voegelin 1942:78; Ray 1963:218). Klamath: (Coville 1897:90). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+3) 334 cal / 100 g. (Simms 1984:146) **B** (+2) 374 cal / hr. (Simms 1984:257 Appendix). **C** (+1) (*Ibid.*:255-257) **D** (+1) **E** (+0) Note: Although *Typha latifolia* pollen has a potentially high rate of return, it is not mentioned in the ethnographic sources used in this study.

Rumex spp. (dock: seed) Total=21
Biogeographic and Temporal Availability Rating: A (+6) **B** (+3) Aug., Sept., Oct., Nov. **C** (+4) Note: *R. salicifolius* J.A. Weinm is the sp. mentioned in the ethnographic record and found within the study area.
Ethnographic Rating: A (+2) Modoc: Ray 1963:215 Appendix II). Klamath: (Coville 1897:95). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 240 cal / 100 g. Estimated **B** (+2) 300 cal / hr. Estimated. Stands are patchy and seldom densely populated. **C** (+2) **D** (+1) **E** (-1)

Prunus virginiana L. (chokecherry: fruit, seed) Total=21
Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) Sept. **C** (+1) Little fruit production within the study area 1992-1995.
Ethnographic Rating: A (+6) Shasta: (Holt 1946:308,341). Modoc: (Voegelin 1942:60; Ray 1963:200). Klamath: (Coville 1897:98). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+4) Shasta: (Holt 1946:308). Modoc: (Voegelin 1942:60). Karuk: Noted as "not preserved" (Schenck and Gifford 1952:384).
Nutritional and Energetic Rating: A (+1) 48 cal / 100 g. Based on data from *Prunus avium* L. (Kuhnlein and Turner 1991:450 Table 6A). Undoubtedly higher when processed with seeds. **B** (+1) <250 cal / hr. Based on gathering trials by Todt near Keno, OR, 1992-1995. Significantly higher return rates obtained from nearby Rogue Valley, OR. **C** (+3) +2 if seeds are processed as well. **D** (+2) Vitamin C if eaten fresh (Kuhnlein and Turner 1991:450 Table 6A). **E** (-1)

Vitis californica Benth. (western wild grape: fruit) Total=21
Biogeographic and Temporal Availability Rating: A (+6) **B** (+2) Sept., Oct. **C** (+1)
Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1952:386). **B** (+0) **C** (+3) Shasta: (Holt 1946:308).
Nutritional and Energetic Rating: A (+1) 63 cal / 100 g. Based on data from *V. vinifera* L. (Kuhnlein and Turner 1991:468 Table 6A). **B** (+1) <250 cal / hr. within study area. **C** (+3) **D** (+2) Some *Vitis* spp. have a high vitamin C content (Kuhnlein and Turner 1991:468 Table 6A). **E** (-2) Note: *V. californica* seldom bears fruit within the study area.

Cornus glabrata Benth. (smooth dogwood: fruit) Total=20
Biogeographic and Temporal Availability Rating: A (+6) **B** (+1) Oct. **C** (+3)
Ethnographic Rating: A (+3) Shasta: (Merriam 1907:20) **B** (+1) **C** (+0)
Nutritional and Energetic Rating: A (+1) 52 cal/100g. From data pertaining to *Cornus canadensis* (Kuhnlein and Turner 1991:444 Table 6A). **B** (+2) 500 cal / hr. Estimated. **C** (+3) Cooked (Merriam 1907:20). **D** (+1) **E** (+0)? Note: The fruit of *Cornus sericea* L., a much less abundant species, was probably used as well.

Bryoria sp. (black lichen: foliage) Total=20
Biogeographic and Temporal Availability Rating: A (+5) **B** (+4) Mar.- Dec. **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:87). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) Estimated **B** (+2) Estimated **C** (+1) High processing requirements to remove toxic vulpic acid. Processing usually involves pounding, soaking and pit-cooking (Kuhnlein and Turner 1991:34). **D** (+1)? **E** (+0)

Lomatium piperi J. Coulter & Rose (desert parsley, wild parsnip: tuber) Total=20

Biogeographic and Temporal Availability Rating: A (+2) **B** (+3) April, May (Ray 1963:198) **C** (+3)

Ethnographic Rating: A (+2) Shasta: *Lomatium* spp. not specifically mentioned but the term "turnip" as used in deAngulo (1950:323-377) likely refers to this genus. Modoc: (Ray 1963:198). Reference is to *L. canbyi.* (J. Coulter & Rose) J. Coulter & Rose. Klamath: "used comparatively little" (Coville 1897:102). Reference is to *L. canbyi.* **B** (+1) (*Ibid.*). Reference is to *L. canbyi.* **C** (+2) Modoc: (Ray 1963:198). Klamath: (Coville 1897:102).

Nutritional and Energetic Rating: A (+2) 119 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+2) >250 cal / hr. Tubers are quite small. **C** (+3)? **D** (+1) **E** (-1) Small disjunct stands. Note: This species is highly regarded on the Columbia Plateau (Hunn 1990:102 Table 6) so it is unlikely that it would have been ignored in the Upper Klamath area. Another, more common species which may have been used is *L. macrocarpum* (Nutt.) Coult. & Rose.

Lomatium nudicaule (pestle lomatium: stem) Total=20

Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) May **C** (+3)

Ethnographic Rating: A (+3) Shasta: (Holt 1946:309) "Wild parsley" probably *L. nudicaule.* Also used by Klamath, but not in Coville (1897); referenced in Gatschet (1890). **B** (+0) **C** (+3) Shasta: (Holt 1946:309).

Nutritional and Energetic Rating: A (+1) <100 cal / 100 g. Greens generally low in calories. **B** (+1) <250 cal / hr. Greens have a low return rate. **C** (+4) if eaten raw, (+3) if steamed and dried. **D** (+2) vitamin C (Norton *et al* 1984:225 Table III) **E** (-1)

Scirpus acutus Bigelow (tule, hardstem bulrush: seed) Total=19

Biogeographic and Temporal Availability Rating: A (+4) **B** (+2) Aug., Sept., Oct. (Simms 1984:248). **C** (+4)

Ethnographic Rating: A (+1) Klamath: (Coville 1897:92). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+3) 305 cal / 100 g. (Simms 1984:207 Appendix, Table II). **B** (+2) 800-1000 cal / hr. for average situation (*Ibid.*:248 Appendix, Table II). **C** (+2) (*Ibid.*) **D** (+1) **E** (+0)

Pinus lambertiana (sugar pine: sap crystals) Total = 19

Biogeographic and Temporal Availability Rating: A (+5) Historic evidence (Klamath Echoes 1966:45; LaLande 1987:35) indicates there were a large number of trees located in the northern portion of the study area. Presently scarce. **B** (+2) Aug., Sept., Oct. During and after the burning season. **C** (+2) Depending upon geography of fire occurrence.

Ethnographic Rating: A (+4) Shasta: (Dixon 1904: 424). Karuk: (Schenck and Gifford 1952:377). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+2) 200- 300 cal / 100 g. Estimated. **B** (+1) <250 cal / hr. Usually gathered and eaten in small quantities (Dixon 1904:424). **C** (+4) (Schenck and Gifford 1952:377). **D** (+1) ? **E** (-2)

Rubus ursinus Cham. & Schldl. (Pacific blackberry: fruit) Total=19

Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) June **C** (+1)

Ethnographic Rating: A (+6) Shasta: (Dixon 1907:424; Holt 1946:308). Modoc: (Ray 1963:215 Appendix II). Klamath: (Coville 1897:99). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+3) Shasta: (Dixon 1907:424; Holt 1946:308). Karuk: "not preserved" (Schenck and Gifford 1952:384).

Nutritional and Energetic Rating: A (+1) 56 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+1) <250 cal / 100 g. Stands small and scattered. **C** (+4) For fresh rather than dried fruit. **D** (+2) Vitamin C (Kuhnlein and Turner 1991:458 Table 6A) **E** (-2)

Lilium pardalinum Kellogg ssp. *vollmeri* (Eastw.) M. Skinner (tiger lily: rhizome) Total=18
Biogeographic and Temporal Availability Rating: A (+2) **B** (+2) April- Oct.? **C** (+4)
Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1952:381). Reference is to *Lilium pardalinum*. **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 100 cal/ 100 g. based on an average value for geophytes. **B** (+2) >250 cal/ hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Darmera peltata (Torrey) Voss (Indian rhubarb, umbrella plant: greens) Total=18
Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) May **C** (+4)
Ethnographic Rating: A (+4) Shasta (Gamutwa): (Holt 1946:309). Karuk: (Schenck and Gifford 1952:384). **B:** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) <250 cal / hr. Foliage has a low caloric return rate. **B** (+1) <250 cal / hr. **C** (+4) **D** (+2) ? No nutritional information on this species, but greens often have high vitamin content. **E** (-1) Note: Found in one location only. Possibly introduced.

Dichelostema capitatum Alph. Wood (blue dicks, brodiaea, snake-heads- corm) Total=18
Biogeographic and Temporal Availability Rating: A (+4) **B** (+3) May-June, Sept.-Nov **C** (+3)
Ethnographic Rating: A (+4) Shasta: M. Carpelan (personal communication, 1998). Karuk: (Schenck and Gifford 1952:380) but not given a use. It might be supposed that use is similar to the species listed previously in Schenck and Gifford 1952: *Brodiaea laxa* (= *Triteleia laxa* Benth.) **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 100 cal/100 g. Based on a standard caloric value for geophytes. **B** (+1) <250 cal/hr. Estimated. Deep-rooted and difficult to dig in rocky soil. **C** (+2) Processing probably similar to that described for *Triteleia laxa* (*Ibid.*) **D** (+1) **E** (-2)

Rosa spp. (wild rose: fruit) Total=18
Biogeographic and Temporal Availability Rating: A (+4) **B** (+3) Aug., Sept., Oct., Nov. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:214, 218 Appendix II). Klamath: (Coville 1897:99). **B** (+0) **C** (+0) Note: Roses are treated generically within the Ethnographic Rating. *Rosa* spp. found within the study area include: *R. californica* Cham & Schldl., *R. gymnocarpa* Nutt., *R. woodsii* Lindley and *R. pisocarpa* A. Gray.
Nutritional and Energetic Rating: A (+1) 74 cal / 100 g. Data derived from *R. nutkana* Presl (Kuhnlein and Turner 1991:456 Table 6A). **B** (+1) <250 cal / hr. **C** (+4) **D** (+2) Vitamin C and A (*Ibid.*). **E** (-2)

Fritillaria recurva Benth. (scarlet fritillary, red-bells: bulb) Total=17
Biogeographic and Temporal Availability Rating: A (+3) Biogeographic abundance increased from +2 to +3 based on the likelihood of decreased abundance during the historic period. **B** (+3) March- April, July- Nov.? **C** (+3) Perhaps due to fluctuations in the populations of burrowing rodents.
Ethnographic Rating: A (+3) Shasta: (Holt 1946:308). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 98 cal / 100 g. From *F. camschatcensis* (L.) Ker-Gawl (Kuhnlein and Turner 1991:354 Table 3A). **B** (+2) 500 cal / hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Carex spp. (sedge: stems) Total=17
Biogeographic and Temporal Availability Rating: A (+3) **B** (+2) March- June? **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:92). **B** (+0) **C** (+0)

Nutritional and Energetic Rating: A (+1) <100 cal / 100 g. Most stem and leaf tissues have low caloric values. **B** (+1) <250 cal / hr. Estimated. **C** (+3) Peeling. **D** (+1)? **E** (+0)

Scirpus acutus Bigelow (tule, hardstem bulrush: rhizome) Total=17
Biogeographic and Temporal Availability Rating: A (+4) **B** (+3) July: Nov. + (?) See discussion in Simms (1984:252). **C** (+4)
Ethnographic Rating: A (+1) Modoc: (Ray l963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 63 cal / 100 g. (Simms 1984:251 Appendix). **B** (+1) <250 cal / hr. (*Ibid.*:249-251). **C** (+2) **D** (+1) **E** (+0)

Sparganium sp. (bur-reed: rootstock and base of stem) Total=17
Biogeographic and Temporal Availability Rating: A (+3) **B** (+3) ? July-Oct.? **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:90). Karuk: "The Karuk do not use this" (Schenck and Gifford 1952:379). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 100 cal / 100 g. An average for starchy roots, tubers, etc. **B** (+1) <250 cal / hr. Populations not concentrated. **C** (+3)? **D** (+1) **E** (-2)

Balsamorhiza sagittata (arrow-leaf balsamroot: seeds) Total=17
Biogeographic and Temporal Availability Rating: A (+4) **B** (+2) July, Aug. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:l06). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 300 cal / l00 g. Estimated. **B** (+1) <250 cal / 100 g. Estimated. *Balsamorhiza* spp. seeds are small and chaffy. **C** (+1) **D** (+2) *Helianthus annuus*, within the same family, has high values for P, K and Mg (Kuhnlein and Turner 1991:429 Table 5B). **E** (-2)

Eriogonum spp. (Eriogonum, wild buckwheat: seeds) Total=16
Biogeographic and Temporal Availability Rating: A (+4) **B** (+2) Sept., Oct. **C** (+3)
Ethnographic Rating: A (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+3) 425 cal/100g. Data derived from *Polygonum convolvulus* L., a plant within the same family (Kuhnlein and Turner 1991:434 Table 5A). **B** (+2) 500 cal / hr. 500-600 cal / hr. is a typical return rate for small seeds (Simms 1984:86 Table 2). **C** (+1) **D** (+1) **E** (-1)

Calochortus macrocarpus Douglas (mariposa lily: bulb) Total=16
Biogeographic and Temporal Availability Rating: A (+3) Geographic abundance rating increased from +2 to +3 due to the likelihood of decreased abundance during the historic period. **B** (+3) April- May, Sept.- Nov. **C** (+3)
Ethnographic Rating: A (+2) Shasta: Within the Shasta ethnographic record, the genus *Calochortus* is often misapplied (Todt 1997:253-255). Modoc: Ray (1963: 218 Appendix II). Klamath: (Coville 1897:93). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 67 cal / 100 g. Based on an average of three Liliaceous spp. (Kuhnlein and Turner 1991:352 Table 3A). **B** (+2) 400 cal / hr. Estimated. **C** (+2) **D** (+1) **D** (-1)

Eriogonum nudum Benth (naked-stem eriogonum: stem) Total=16
Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) May **C** (+3)
Ethnographic Rating: A (+1) Karuk: (Schenck and Gifford 1952:383). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) <l00 cal / l00 g. **B** (+1) <250 cal / hr. Estimated. **C** (+4) **D** (+2)? Probably vitamin C. **E** (+0)

Rubus leucodermis Torry & A. Gray (black raspberry, blackcap: fruit) Total=16
Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) Aug. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:215 Appendix II). Klamath: (Coville 1897:99). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+1) Klamath: (Coville 1897:99).

Nutritional and Energetic Rating: A (+1) 65 cal / 100 g. Derived from data pertaining to *R. idaeus* (Kuhnlein and Turner 1991:456 Table 6A). **B** (+1) <250 cal / hr. Stands small and scattered. **C** (+4) For fresh rather than dried fruit. **D** (+2) vitamin C. Three *Rubus* spp. yielded an average of 63.7 mg / 100 g. of vitamin C (Kuhnlein and Turner 1991:456 Table 6A). **E** (-2)

Rubus parviflorus Nutt. (thimbleberry: fruit) Total=16
Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) Late July, early Aug. **C** (+3)
Ethnographic Rating: A (+4) Shasta: (Holt 1946:308). Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+0)
Nutritional and Energetic rating: A(+1) 54 cal / 100 g. (Norton *et al* 1984:223-4 Table I) **B** (+1) <250 cal / hr. Stands small and scattered. **C** (+4) **D** (+2) Vit. A. An average of three *Rubus* spp. yielded 63.7 mg of vit. C / 100 g. (Kuhnlein and Turner 1991:456 Table 6A). **E** (-2)

Descurainia pinnata (Walter) Britton (tansy mustard: seeds) Total=15
Biogeographic and Temporal Availability Rating: A (+3) **B** (+1) Lt. June, early July. **C** (+3)
Ethnographic Rating: A (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+3) 350 cal / 100 g. (Simms 1984:144 Table 8). **B** (+2) 500 cal / hr. Derived from figures in Simms (1984:215 Appendix) but downgraded since stands within the study area are small and often not well stocked. **C** (+2) **D** (+1) **E** (-1)

Mentzelia laevicaulis (Hook.) Torrey & A. Gray (blazing star: seeds) Total=15
Biogeographic and Temporal Availability Rating: A (+2) **B** (+2) Sept., Oct., Nov. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II: reference is actually to the related *M. albicaulis* Hook). Klamath: (Coville 1897:100). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 460 cal / 100 g. Assigned a value slightly below an average value for seeds (Kuhnlein and Turner 1991:422-428 Table 5A). **B** (+2) 400 cal / hr. Estimated. **C** (+2) **D** (+1) **E** (-1)

Pinus contorta Loudon (lodgepole pine: inner bark) Total=15
Biogeographic and Temporal Availability Rating: A (+1) **B** (+1) April (Coville 1897:89). **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:89). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+2) 103 cal / 100 g. Data from *Tsuga heterophylla* (Kuhnlein and Turner 1991:346 Table 1A). **B** (+2) 400 cal / hr. Estimated. **C** (+4) **D** (+1) **E** (-2)

Allium spp. (wild onion: bulb) Total=15
Biogeographic and Temporal Availability Rating: A (+3) **B** (+3) Mar.: Nov. **C** (+4)
Ethnographic Rating: A(+1) Karuk: (Schenck and Gifford 1952:380). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 61 cal / 100 g. Data derived from the related Liliaceous bulb of *Camassia quamash* (Couture *et al.* 1965:58). **B** (+1) <250 cal / hr. Onions have patchy distributions, are usually located in lithosols and the bulbs are of small size. More than 5 species are located within the study area. **C** (+2) **D** (+1) **E** (-1)

Chrysolepis sempervirens (Kellogg) Hjelmq. (shrub chinquapin: seed) Total=15
Biogeographic and Temporal Availability Rating: A (+2) **B** (+2) Sept., Oct., Nov. **C** (+2)
Ethnographic Rating: A (+2) Klamath: (Coville 1897:94). Karuk: (Schenck and Gifford 1952:383). **B** (+0) **C** (+1) Karuk: (Schenck and Gifford 1952:383).

Nutritional and Energetic Rating: A (+2) 213 cal / 100 g. for a related *Castanea* sp. (Kuhnlein and Turner 1991:426 Table 5A). **B** (+1) <250 cal / hr.: a low estimate due to high percentage of insect infestation. **C** (+3) **D** (+1) **E** (-1)

Leymus cinereus (Scribner and Merr.) A. Love (giant wild rye: seeds) Total=15
Biogeographical and Temporal Availability Rating: A (+3) **B** (+1) Sept. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218, Appendix II). Klamath: (Coville 1897:91). **B** (+0) **C** (+0)
Nutritional and Energetic Raing: A (+2) 280 cal / 100 g. (Simms 1984:206, Appendix, Table II) **B** (+2) 550 cal / hr. (Simms 1984:86 Table II) **C** (+2) **D** (+1) **E** (-1)

Elymus glaucus Buckl. (blue wild rye: seeds) Total=14
Biogeographic and Temporal Availability Rating: A (+3) Abundance rating increased from +2 to +3 since it was likely more abundant before contact. **B** (+1) late August-early Sept. **C** (+3)
Ethnographic Rating: A (+1) Karuk: (Schenck and Gifford 1952:380). **B** (+0) **C** (+0) ?
Nutritional and Energetic Rating A (+2) 280 cal / 100 g. (Simms: 1984: 206 Appendix, Table II: data for *Leymus cinereus).* **B** (+2) 550 cal / hr. Data derived from *Leymus cinereus* (Simms 1984: 86 Table 2). **C** (+2) **D** (+1) **E** (-1)

Arctostaphylos nevadensis A. Gray (pine-mat manzanita: fruit) Total=14
Biogeographic and Temporal Availability Rating: A (+2) **B** (+2) Aug.- Sept. **C** (+2)
Ethnographic Rating A: (+2) Modoc: (Ray 1963: 219 Appendix II). Karuk: (Schenck and Gifford 1952:388). **B** (+0) **C** (+2) In this case use probably implies processing, drying and storage.
Nutritional and Energetic Rating: A (+1) 90 cal / 100 g. data derived from *A. uva-ursi* (Kuhnlein and Turner 1991:442 Table 6A). **B** (+1) < 250 cal / hr. Estimated. **C** (+2) **D** (+2) High vitamin C content listed for two other *Arctostaphylos* spp. (Kuhnlein and Turner 1991:442 Table 6A).**E** (-2) Note: Diseased and low fruit production in Upper Klamath River vicinity.

Fragaria vesca L. (wild strawberry: fruit) Total=14
Biogeographic and Temporal Availability Rating: A (+4) **B** (+1) July **C** (+2)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:98). Species listed as *F. virginiana* Duchesne. Karuk: (Schenck and Gifford 1952:384). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 54 cal / 100 g. for *F. vesca* (Kuhnlein and Turner 1991:446 Table 6A). **B** (+1) <250 cal / hr. Fruit seldom abundant or ripe at same time. **C** (+4) **D** (+1) **E** (-2)

Heracleum lanatum Michaux (cow parsnip: stalks) Total=14
Biogeographic and Temporal Availability Rating: A (+1) **B** (+2) April, May **C** (+4)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:102). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 20 cal / 100 g. peeled shoots (Kuhnlein and Turner 1991:390 Table 4A). **B** (+1) <250 cal / hr. Low population densities. **C** (+3) **D** (+2) (Norton *et al* 1984:225 Table III). **E** (-2)

Helianthus bolanderi A. Gray (sunflower, Bolander's sunflower: seeds) Total=13
Biogeographic and Temporal Availability: **Rating A** (+2) **B** (+2) Sept., Oct. **C** (+2)
Ethnographic Rating: A (+1) Modoc: (Ray 1963: 218 Appendix II) reference is to *H. cusickii* A. Gray, *H. nuttallii* Torrey & A. Gray. **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+3) 365 cal / 100 g. (Simms 1984:206 Table II: reference to *H. annuus*) . **B** (+2) 300 cal / hr. based on Simms (1984:206 Appendix) data but decreased since local populations are scattered and sparse. **C** (+2) **D** (+1) **E** (-2)

Grindelia sp. (gumweed: foliage) Total=13
Biogeographic and Temporal Availability Rating: A (+2) **B** (+1) May **C** (+3)
Ethnographic Rating: A (+1) Karuk: (Schenck and Gifford 1952:389). Species listed as *G. robusta* (= *G. camporum* E. Greene). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 45 cal / 100 g. Average caloric value for four Asteraceae spp. (Kuhnlein and Turner 1991:370, 382, 392, 416 Table 4A). **B** (+1) < 250 cal / hr. Stands small and very scattered. **C** (+4) **D** (+2) vitamin C (*Ibid.*). **E** (-2)

Phragmites australis (Cav.) Steudel (giant reed grass: seeds) Total=13
Biogeographic and Temporal Availability Rating: A (+2) Geographic abundance increased from +1 to +2 since it may have been more abundant prehistorically. **B** (+1) Sept. **C** (+3)
Ethnographic Rating: A (+2) Modoc: (Ray 1963:218 Appendix II). Klamath: (Coville 1897:91). **B** (+0) **C** (+0) ?, though probably stored when a sufficient quantity was harvested.
Nutritional and Energetic Rating: A (+2) 261 cal / 100 g. (Simms 1984:206 Appendix II) for *Phalaris arundinacea* L. **B** (+2) 300 cal / hr. based on small, scattered stands. **C** (+2) **D** (+1) **E** (-2)

Pinus contorta (lodgepole pine: seeds) Total=13
Biogeographical and Temporal Availability Rating: A (+1) **B**(+2) Sept., Oct. **C** (+4)
Ethnographic Rating: A (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+3) 400 cal / 100 g. **B** (+1) ? <250 cal / hr. Cones small, seeds small. **C** (+2) **D** (+1) **E** (-2) Note: Rare within study area.

Prunus emarginata (Hook.) Walp. (bittercherry: fruit) Total=12
Biogeographic and Temporal Availability: A (+2) **B** (+2) Sept. **C** (+3)
Ethnographic Rating: A (+1) Modoc: (Ray 1963:218 Appendix II). **B** (+0) **C** (+0)
Nutritional and Energetic Rating: A (+1) 48 cal / 100 g. Based on data from *Prunus avium* (Kuhnlein and Turner 1991:450 Table 6A). **B** (+1) <250 cal / hr. Fruits usually sparsely distributed on plants; stands discontinuous. **C** (+3) ? **D** (+1) **E** (-2)

Journal of Ethnobiology 18(2):309-316 Winter 1998

RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS XVI

TERENCE E. HAYS
Department of Anthropology and Gegraphy
Rhode Island College
Providence, RI 02908 USA

ABSTRACT. — This bibliography includes recent dissertations of interest to ethnobiologists. For each is given the page number where it may be found in Dissertation Abstracts (D.A.) and the order number for dissertation copies from University Microfilm International, P.O. Box 1764, Ann Arbor, Michigan 48106-1346 U.S.A. (Telephone: 1-800-521-3042; 1-800-343-5299 from Canada).

RESUMEN. — En este bibliografía se incluyen disertaciones recientes de interés a los etnobiólogos. Por cada uno se da el número de la página donde se halla el resumen en Dissertation Abstracts (D.A.), y el número de encargar un ejemplar de la disertación de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106-1346 USA (telefono: 1-800-521-3042; desde Canada 1-800-343-5299).

RÉSUMÉ. — Cette bibliographie comprend quelques dissertationes recentes d'interet aux ethnobiologistes. Chez chaqu-une on donne le numéro de la page où se trouve le résumé dans Dissertation Abstracts (D.A.), et le numéro de commander un exemplaire de la dissertations de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106- 1346 USA (telephone: 1-800-521-3042; de Canada 1-800-343-5299).

INTRODUCTION

This is the sixteenth in an annual series of bibliographies listing selected dissertations drawn from the pages of Dissertation Abstracts (D.A.). All listings were made by scanning the titles and abstracts published in D.A. and making subjective decisions as to which ones might be relevant to work in ethnobiology or related disciplines such as ecological anthropology and economic botany.

Dissertations categorized in D.A. under Agricultural Economics, Agriculture, American Studies, Anthropology, Botany, Ecology, Environmental Sciences, Folklore, Geography, Language, Linguistics, Nutrition, Palaeobotany, Paleoecology, Paleozoology, Palynology, Veterinary Science, and Zoology were considered for inclusion in the list. An attempt was made to be as inclusive as possible, but some dissertations may have been overlooked. Comments and suggestions would be welcome for items to include in next year's edition.

Dates covered by the present paper include: Volume A (Humanities and Social Sciences): September 1997- August 1998 and Volume B (Sciences and Engineering): September 1997-August 1998 Note that these are the dates for the issues of D.A. in which the abstracts appear, rather than the dates of acceptance of the dissertations themselves.

The dissertations are listed below alphabetically by author, along with the year of acceptance, title, institution, length, adviser or major professor, number(s) of the page(s) in D.A. on which the abstract may be found, University Microfilms order number, and the ISBN number when this information was included.

Most of the dissertations accepted at institutions in the United States, and some of those from Australia, Canada, South Africa, and the United Kingdom may be obtained from University Microfilms International, either on microfilm or published by microfilm xerography. Quality of printed matter is generally excellent, but that of figures and photographs varies with the quality of the original. Current prices may be obtained by calling 1-800-521-3042; or 1-800-343-5299 from Canada. Further information and current prices, as well as information regarding how to order dissertations listed above with no UMI order number, may be obtained from UMI Dissertation Services, 300 North Zeeb Road, Ann Arbor, MI 48106-1346, USA.

Abstracts of the dissertations listed below as well as all others included in D.A. are now available online, with the full text of abstracts published since July 1980. This service is updated monthly, and includes UMI's entire dissertation database back to 1861. For further information regarding *Dissertation Abstracts Online* or *Dissertation Abstracts Ondisc* (CD-ROM) consult your local research librarian or UMI at the address given above regarding orders.

Following this usual listing I have appended information regarding three dissertations and theses from Australian universities, kindly provided by Chris Healey. While these are **not available** from University Microfilms International (you might try interlibrary loan), Chris and I agree that they are indeed of interest to ethnobiologists.

AFOLAYAN, ANTHONY JIDE. 1996. The medicinal potential of *Helichrysum aureonitens*. University of Pretoria (South Africa). 1 p. [sic] Supervisor: J.J.M. Meyer. [no Order no.] D.A. 58(3);1054-1055-B.

AHMED, ABDULLA MOHAMED. 1997. Major determinants of agricultural land use in a semi-arid region: Central Tihama, Republic of Yemen. Kent State University, 217 pp. Director: Surinder M. Bhardwaj. Order no. DA9731552. D.A. 58(5):1852-1853-A.

AL-HARATANI, EIJA RAMADAN. 1997. Impacts of modernization on nomads and their use of rangeland resources in At-Taysiyah region, Saudi Arabia. The University of Arizona, 191 pp. Director: Martin M. Fogel. Order no. DA9729421. D.A. 58(4):1777-B.

ALLUM, CLAIRE PAULETTE. 1997. An ethnoarchaeological study of Chachi land-use in northwestern tropical lowland Ecuador. Univerity of Calgary (Canada), 374 pp. Adviser: J.S. Raymond. ISBN: 0-612-20721-8. Order no. DANQ20721. D.A. 58(9):3583-3584-A.

ANDERSON, KATHARINE. 1997. Nature, culture and big old trees: Human relationships with ceiba (*Ceiba pentandra*) and live oak (*Quercus virginiana*) in the landscapes of Guatemala and Louisiana. The Louisiana State University and Agricultural and Mechanical College, 224 pp. Director: Miles E. Richardson. Order no. DA9735974. D.A. 58(6):2337-A.

ARABAS, KAREN BORZA. 1997. Fire and vegetation dynamics in the eastern serpentine barrens. The Pennsylvania State University, 225 pp. Adviser: Alan H. Taylor. Order no. DA9732230. D.A. 58(5):1853-A.

ARELLANO-HERNÁNDEZ, ANTONIO. 1996. L'hybridation du maïs et des agriculteurs dans les hautes vallées du mexique. (La production des objets techniques agricoles). Unversité Laval (Canada), 268 pp. Directeur: Yvan Simonis. In French. ISBN: 0-612-17281-3. Order no. DANN17281. D.A. 58(5):1788-A.

ASWANI, SHANKAR. 1997. Customary sea tenure and artisanal fishing in the Roviana and Vonavona lagoons, Solomon Islands: The evolutionary ecology of marine resource utilization. University of Hawaii, 485 pp. Chairperson: Ben Finney. Order no. DA9801428. D.A. 58(7):2714-A.

BALCET, JEAN-CLAUDE LEON. 1998. Adoption of technology by subsistence farmers in Northern Nigeria. Cornell University, 503 pp. Order no. DA9818462. D.A. 58(12):4743-A.

BARLOW, K. RENEE. 1997. Foragers that farm: A behavioral ecology approach to the economics of corn farming for the Fremont case. The University of Utah, 219 pp. Order no. DA9813182. D.A. 58(11):4321-A.

BATTERBURY, SIMON PEREGRINE JOHN. 1997. The political ecology of environmental management in semi-arid West Africa: Case studies from the Central Plateau, Burkina Faso. Clark University, 382 pp. Adviser: Douglas L. Johnson. Order no. DA9813128. D.A. 58(10):4023-A.

BOAG, FRANCA ELISE. 1997. Integrated Mediterranean farming and pastoral systems: Local knowledge and ecological infrastructure of Italian dryland farming. University of Alberta (Canada), 374 pp. Adviser: Henry T. Lewis. ISBN: 0-612-22954-8. Order no. DANQ22954. D.A. 58(10):3973-A.

BOBE, RENÉ. 1997. Hominid environments in the Pliocene: An analysis of fossil mammals from the Omo Valley, Ethiopia. University of Washington, 252 pp. Chairperson: Gerald G. Eck. Order no. DA9806959. D.A. 58(8):3193-A.

BONHAGE-FREUND, MARY THERESA. 1997. Paleoethnobotany of the Georgia Piedmont: Four Lamar period farmsteads in the middle Oconee uplands. The Pennsylvania State University, 457 pp. Adviser: James W. Hatch. Order no. DA9732277. D.A. 58(5):1784-A.

BROWN, SANDRA JEAN. 1997. Soil fertility, nutrient dynamics and socio-economic interactions in the middle mountains of Nepal. The University of British Columbia (Canada), 254 pp. ISBN: 0-612-25023-7. Order no. DANQ25023. D.A. 59(2):481-482-B.

CAMPBELL, CONSTANCE ELAINE. 1996. Forest, field and factory: Changing livelihood strategies in two extractive reserves in the Brazilian Amazon. University of Florida, 196 pp. Chairperson: Marianne Schmink. Order no. DA9800076. D.A. 58(7):2715-A.

CANADAY, TIMOTHY W. 1997. Prehistoric alpine hunting patterns in the Great Basin. University of Washington, 385 pp. Chairperson: Donald K. Grayson. Order no. DA9736250. D.A. 58(6):2265-A.

CASPER, KAREN LEE. 1997. Household subsistence strategies and well-being in Bangladesh: A quality of life approach to development. University of California, Los Angeles, 414 pp. Chair: Peter B. Hammond. Order no. DA9803510. D.A. 58(8):3188-A.

CHEN, MAA-LING. 1997. Settlement patterns, subsistence systems and their changes in Kenting National Park during O-luan-pi Phases III and IV. Arizona State University, 149 pp. Order no. DA9738311. D.A. 58(6):2265-2266-A.

COLTRAIN, JOHN BRENNER. 1997. Fremont economic diversity: A stable carbon isotope study of formative subsistence practices in the Eastern Great Basin. The University of Utah, 212 pp. Order no. DA9724459. D.A. 58(3):950-A.

DAIGLE, JOHN JOSEPH. 1997. The sociocultural importance of fur trapping in six northeastern states. University of Massachusetts, 233 pp. Director: Robert M. Muth. Order no. DA9737515. D.A. 58(6):2780-2781-B.

DALTON, TIMOTHY JOHN. 1996. Soil degradation and technical change in southern Mali. Purdue University, 260 pp. Major Professor: William A. Masters. Order no. DA9725530. D.A. 58(3):1008-A.

DOCKALL, HELEN MARIE. 1997. Archaic hunter-gatherer adaptation on the inland portion of the West Gulf Coastal Plain: The bioarchaeological evidence. Texas A & M University, 320 pp. Chair: D. Gentry Steele. Order no. DA9729184. D.A. 58(4):1354-A.

EDMUNDS, DAVID STUART. 1997. Continuity and change in the resource management institutions of communities bordering the Kibale Forest Park, Uganda. Clark University, 327 pp. Chief Instructor: Dianne Rocheleau. Order no. DA9729729. D.A. 58(4)1398-A.

EMERY, KATHERINE FRANCES. 1997. The Maya collapse: A zooarchaeological investigation. Cornell University, 672 pp. Adviser: John S. Henderson. Order no. DA9738202. D.A. 58(6):2266-A.

ERTUG-YARAS, FÜSUN. 1997. An ethnoarchaeological study of subsistence and plant gathering in central Anatolia. Washington University, 768 pp. Chairperson: Patty Jo Watson. Order no. DA9730941. D.A. 58(4):1343-A.

FARRELL, MARIE PATRICE. 1997. The garden city hypothesis in the Maya lowlands. University of Cincinatti, 212 pp. Chair: Nicholas P. Dunning. Order no. DA9814477. D.A. 58(11):4399-A.

FERRIS, JOSEPH SALEEM. 1997. Landscape analysis of a lowland tropical forest based on remotely sensed spectral reflectance and thermal response characteristics. University of Georgia, 143 pp. Director: Elgene O. Box. Order no. DA9735512. D.A. 58(6):2819-B.

FITES-KAUFMAN, JOSEPHINE ANN. 1997. Historic landscape pattern and process: Fire, vegetation, and environment interactions in the northern Sierra Nevada. University of Washington, 1 p. [sic] Chairperson: Jerry F. Franklin. [no Order no.] D.A. 58(7):3389-3390-B.

FLICKINGER, DONALD IAN. 1997. Rehabilitation of degraded tropical forests in India's western Ghats: Silvicultural and socio-economic implications of multiple species plantations. University of Florida, 200 pp. Chairman: Nigel J.H. Smith. Order no. DA9824065. D.A. 59(2):579-A.

FORLINE, Louis carlos. 1997. The persistence and cultural transformation of the Guajá Indians: Foragers of Maranho state, Brazil. University of Florida, 339 pp. Chairman: Maxine Margolis. Order no. DA9824067. D.A. 59(2):538-A.

GLAESEL, HEIDI. 1997. Fishers, parks, and power: The socio-environmental dimensions of marine resource decline and protection on the Kenya coast. The University of Wisconsin-Madison, 343 pp. Supervisor: Matthew D. Turner. Order no. DA9734377. D.A. 58(10):4025-A.

GONZALEZ, PATRICK JOSEPH. 1997. Dynamics of biodiversity and human carrying capacity in the Senegal Sahel. University of California, Berkeley, 427 pp. Chair: John P. Holdren. Order no. DA9803206. D.A. 58(8):4016-B.

GRAY, LESLIE CARROLL. 1997. Land degradation in southwestern Burkina Faso: The environmental effects of demographic and agricultural change. University of Illinois at Urbana-Champaign, 277 pp. Adviser: Thomas J. Bassett. Order no. DA9812599. D.A. 58(10):4025-A.

GUNN, MARY MARGARET. 1997. The development of social networks: Subsistence production and exchange between the sixth and sixteenth centuries A.D. in the Tanjay region, Negros Oriental, the Philippines. University of Hawaii, 410 pp. Chairperson: Michael W. Graves. Order no. DA9733606. D.A. 58(5):1785-1786-A.

GUO, XIAOLIN. 1997. Rice ears and cattle tails: A comparative study of rural economy and society in Yunnan, southwest China. The University of British Columbia (Canada), 389 pp. Adviser: Martin G. Silverman. ISBN: 0-612-19585-6. Order no. DANN19585. D.A. 58(6):2271-A.

GURURANI, SHUBRA. 1996. Fuel, fodder, and forests: Politics of forest use and abuse in Uttarakhan Himalaya, India. Syracuse University, 322 pp. Order no. DA9737821. D.A. 58(7):2717-2718-A.

HVENEGAARD, GLEN TIMOTHY. 1996. Tourists, ecotourists, and birders at Doi Inthanon National Park, Thailand. University of Victoria (Canada), 241 pp. Adviser: Philip Dearden. ISBN: 0-612-21935-6. Order no. DANQ21935. D.A. 58(9):3664-A.

JIANG, HONG. 1997. An endangered environmental region: The Ordos Plateau, China. Clark University, 220 pp. Chief Instructor: Roger Kasperson. Order no. DA9726504. D.A. 58(3):1027-A.

JOHNSON, AMBER LYNN. 1997. Explaining variability in the pace and pattern of cultural evolution in the North American Southwest: An exercise in theory building. Southern Methodist University, 129 pp. Adviser: Lewis R. Binford. Order no. DA9728751. D.A. 58(3):951-A.

JOHNSON, LESLIE MAIN. 1997. Health, wholeness, and the land: Gitksan traditional plant use and healing. University of Alberta (Canada), 441 pp. Adviser: Gregory Forth. ISBN: 0-612-22999-8. Order no. DANQ22999. D.A. 58(10):3975-A.

JUDD, NANETTE L. KAPULANI MOSSMAN. 1997. *Laau lapaau*: A geography of Hawaiian herbal healing. University of Hawaii, 231 pp. Chair: Nancy Lewis. Order no. DA9733608. D.A. 58(5):1854-A.

KELERTAS, KRISTINA ALDONA. 1997. Agricultural food systems and social inequality: The archaeobotany of Late Neolithic and Early Bronze Age Thy, Denmark. University of California, Los Angeles, 331 pp. Chair: Timothy Earle. Order no. DA9811460. D.A. 58(10):3972-A.

KLOOSTER, DANIEL JAMES. 1997. Conflict in the commons: Commercial forestry and conservation in Mexican indigenous communities. University of California, Los Angeles, 747 pp. Chair: Judith Carney. Order no. DA9823564. D.A. 59(2):579-580-A.

KODACK, MARC. 1997. Environmental structure and its effect on hunter-gatherer organizational strategies in Eastern Nevada. University of California, Santa Barbara, 454 pp. Order no. DA9800468. D.A. 58(7):2711-A.

KRAUSS, DAVID A. 1997. The use of phytolith analysis in paleoenvironmental reconstruction and environmental management on Martha's Vineyard, Massachusetts. University of Massachusetts at Boston, 264 pp. Directors: Lawrence Kaplan; Eric G. Strauss. Order no. DA9819495. D.A. 58(12):6458-6459-B.

KUNOW, MARIANNA APPEL. 1996. Curing and curers in Pisté, Yucatán, México. Tulane University, 248 pp. Chairman: Victoria R. Bricker. Order no. DA9731947. D.A. 58(5):1793-A.

KYEM, PETER AMOS KWAKU. 1997. A GIS-based strategy for improving local community participation in resource management, allocation and planning: The case of institution building for collaborative forest management in southern Ghana. Clark University, 270 pp. Chief Instructor: Jacque J. Emel. Order no. DA9726507. D.A. 58(3)1027-1028-A.

LEAMAN, DANNA JO. 1996. The medical ethnobotany of the Kenyah of East Kalimantan (Indonesian Borneo). University of Ottawa (Canada), 385 pp. Advisers: John T. Arnason; Timothy Johns. ISBN: 0-612-16420-9. Order no. DANN16420. D.A. 58(4):1627-B.

LEPPMAN, ELIZABETH JANE. 1997. Choices in the rice bowl: Geography of diet in Liaoning Province, China. University of Georgia, 426 pp. Director: Clifton W. Pannell. Order no. DA9735535. D.A. 58(6):2339-A.

LI, KUANG-TI. 1997. Change and stability in the dietary system of a prehistoric coastal population in southern Taiwan. Arizona State University, 301 pp. Order no. DA97348-67. D.A. 58(5):1786-A.

LINDLEY, JOHN MICHAEL. 1997. The Zagros Mousterian: A regional perspective. Arizona State University, 425 pp. Order no. DA9738323. D.A. 58(6):2267-A.

LUCAS, KIMBERLEY. 1997. Risky business: Agricultural diversification and social relations in the Southern Highlands of Tanzania. University of Kentucky, 399 pp. Director: Peter D. Little. Order no. DA9735622. D.A. 58(6):2272-2273-A.

LYE, TUCK PO. 1997. Knowledge, forest, and hunter-gatherer movement: The Batek of Pahang, Malaysia. University of Hawaii, 482 pp. Chairperson: P. Bion Griffin. Order no. DA9801452. D.A. 58(7):2719-A.

MALAINEY, MARY EVELYN. 1997. The reconstruction and testing of subsistence and settlement strategies for the plains, parkland and southern boreal forest. The University of Manitoba (Canada), 344 pp. Adviser: B.L. Sherriff. ISBN: 0-612-23635-A. Order no. DANQ26365. D.A. 58(11):4322-A.

MEREDIG, JOHN S. 1997. Russian bird names: A linguistic analysis. University of Illinois at Urbana-Champaign, 394 pp. Adviser: Frank Y. Gladney. Order no. DA9812705. D.A. 58(10):3907-A.

MOLNAR, JAMES STEPHEN. 1997. Interpreting fishing strategies of the Odawa. State University of New York at Albany, 214 pp. Order no. DA9733499. D.A. 58(5):1786-A.

MORIN, STEPHEN ROBERT. 1997. Common property and exchange in a natural resource management system: A case study from northern Sumatra. University of Kentucky, 218 pp. Director: John van Willigen. Order no. DA9735623. D.A. 58(6):2274-A.

MULLEN, CHRISTINE OWEN. 1997. Mammalian response to Pleistocene/Holocene environmental change in the Great basin: The jackrabbit's tale. University of Nevada, Reno, 119 pp. Adviser: Peter F. Brussard. Order no. DA9816989. D.A. 58(11):5864-B.

NAGY, MURIELL IDA. 1997. Palaeoeskimo cultural transition: A case study from Ivujivik, Eastern Arctic. University of Alberta (Canada), 326 pp. Adviser: Raymond Le Blanc. ISBN: 0-612-21609-8. Order no. DANQ21609. D.A. 58(9):3584-3585-A.

OLIVE, CARON. 1997. Land use change and sustainable development in Segara Anakan, Java, Indonesia: Interactions among society, environment and development. University of Waterloo (Canada), 250 pp. Advisers: Gordon Nelson; Ellsworth LeDrew. ISBN: 0-612-21374-9. D.A. 58(9):3664-A.

PEACOCK, SANDRA LESLIE. 1998. Putting down roots: The emergence of wild plant food production on the Canadian Plateau. University of Victoria (Canada), 375 pp. Supervisors: Dr. Nancy J. Turner and Dr. M.C.R. Edgell.

PELLATT, MARLOW GREGORY. 1996. Postglacial changes in vegetation and climate near tree-line in British Columbia. Simon Fraser University (Canada), 225 pp. Adviser: Rolf W. Mathewes. ISBN: 0-612-17046-2. Order no. DANN17046. D.A. 58(4):1771-B.

PERRY, DAVID WAYNE. 1997. The archaeology of hunter-gatherers: Plant use in the Dutch Mesolithic. New York University, 326 pp. Order no. DA9731428. D.A. 58(4):1344-1345-A.

PETERKIN, GAIL LARSEN. 1997. Upper Palaeolithic hunting technology and prey selection in southwest France. Tulane University, 766 pp. Chairman: Harvey M. Bricker. Order no. DA9732439. D.A. 58(5):1786-1787-A.

POTTER, JAMES MICHAEL. 1997. Communal ritual feasting, and social differentiation in late prehistoric Zuni communities. Arizona State University, 266 pp. Order no. DA9738330. D.A. 58(6):2267-2268-A.

PROSE, PATRICK HUGH. 1997. Effects of seasonal prescribed fires on oak-dominated shelterwood stands. Clemson University, 169 pp. Adviser: David H. Van Lear. Order no. DA9816571. D.A. 58(11):57-20-B.

PURI, RAJINDRA KUMAR. 1997. Hunting knowledge of the Penan Benalui of East Kalimantan, Indonesia. University of Hawaii, 496 pp. Chairperson: Leslie E. Sponsel. Order no. DA9801456. D.A. 58(7):2720-A.

REASONER, MELTON AARON. 1996. Late Quaternary alpine and subalpine lacustrine records: Canadian and Colorado Rocky Mountains. University of Alberta (Canada), 151 pp. Adviser: N.W. Rutter. ISBN: 0-612-18097-2. Order no. DANN18097. D.A. 58(6):2931-B.

ROTH, LINDA C. 1997. Traditional knowledge and management of subtropical dry forest: A study of resource use, landscape change, and biodiversity in a rural area of the Dominican Republic. Clark University, 295 pp. Chief Instructor: Dianne E. Rocheleau. Order no. DA9726501. D.A. 58(3):1028-A.

RUBY, BRET JAMES. 1997. The Mann phase: Hopewellian subsistence and settlement adaptations in the Wabash Lowlands of southwestern Indiana. Indiana University, 660 pp. Chairperson: Patrick J. Munson. Order no. DA9825476. D.A. 59(2):534-A.

SAUL, DARIN ALLEN. 1996. Restoring culture and nature: Land use and ecology in the Palouse River watershed. Washington State University, 183 pp. Chair: John Ehrstine. Order no. DA9731118. D.A. 58(4):1352-A.

SEGOSEBE, EAGILWE M. 1997. Pastoral management in Botswana: A comparative study of private and communal grazing management in the Kweneng and Southern District. Clark University, 330 pp. Chief Instructor: Douglas L. Johnson. Order no. DA9809054. D.A. 58(9):3665-A.

SEMPLE, HUGH MORTIMER. 1997. Agricultural change and the decline of domestic food production in Guyana, 1960-1994. The University of Manitoba (Canada), 282 pp. Adviser: John Brierley. ISBN: 0-612-16279-6. Order no. DANN16279. D.A. 58(4):1400-A.

SIQUEIRA, ANDRÉA DALLEDONE. 1997. The ecology of food and nutrition: Patterns of land use and nutritional status among Caboclo populations on Marajó Island, Pará, Brazil. Indiana University, 404 pp. Order no. DA9810794. D.A. 58(9):3590-A.

SMITH, BEVERLY ANN. 1996. Systems of subsistence and networks of exchange in the Terminal Woodland and Early Historic periods in the Upper Great Lakes. Michigan State University, 339 pp. Order no. DA9734190. D.A. 58(5):1787-A.

SMITH, KEVIN CHRISTOPHER. 1997. From livestock to land: The effects of agricultural sedentarization on pastoral Rendille and Ariaal on [sic] northern Kenya. The Pennsylvania State University, 297 pp. Adviser: Patricia Draper. Order no. DA9802751. D.A. 58(7):2721-A.

SPENCE, BALFOUR ALBERT BARNSWELL. 1996. Domestic food production and small farming in Jamaica. The University of Manitoba (Canada), 462 pp. Adviser: J.S. Brierley. ISBN: 0-612-16304-0. Order no. DANN16304. D.A. 58(4):1400-1401-A.

STRASBERG, PAUL J. 1997. Smallholder cash-cropping, food-cropping and food security in northern Mozambique. Michigan State University, 279 pp. Order no. DA9734196. D.A. 58(5):1833-A.

SZYMANSKI, MARCELLA BRIAN. 1997. Socio-economic analysis of an agroforestry system with the Winnebago Tribe of Nebraska. Iowa State University, 77 pp. Major Professor: Joe P. Colletti. Order no. DA9737763. D.A. 58(6):2782-2783-B.

TAKAMIYA, HIROTO. 1997. Subsistence adaptation processes in the prehistory of Okinawa. University of California, Los Angeles, 341 pp. Chair: Timothy K. Earle. Order no. DA9803502. D.A. 58(7):2713-A.

TIPPITT, V. ANN. 1997. The Early to Middle Archaic transition in the Georgia-Carolina Piedmont: A view from the Gregg Shoals site. The University of North Carolina at Chapel Hill, 208 pp. Director: Carole L. Crumley. Order no. DA9730616. D.A. 58(4):1345-A.

TOWNER, RONALD HUGH. 1997. The dendrochronology of the Navajo pueblitos of Dinétah. The University of Arizona, 465 pp. Co-Chairs: Jeffrey S. Dean; J. Jefferson Reid. Order no. DA9729440. D.A. 58(4):1345-A.

VARDY, SHEILA RUTH. 1997. Climate change and postglacial environmental history of permafrost peatlands in the Mackenzie Delta area, N.W.T. University of Waterloo (Canada), 157 pp. Adviser: Barry G. Warner. ISBN: 0-612-21394-3. Order no. DANQ21394. D.A. 58(9):4689-B.

WADLEY, REED LEE. 1997. Circular labor migration and subsistence agriculture: A case of the Iban in West Kalimantan, Indonesia. Arizona State University, 284 pp. Adviser: John F. Martin. Order no. DA9811824. D.A. 58(10):3977-3978-A.

WALTERS, JEFFREY SPRAGUE. 1997. Exploring local knowledge of tropical coastal ecology: Participating resource assessment in a Philippine fishing community. University of Hawaii, 228 pp. Chairperson: Nancy D. Lewis. Order no. DA9816750. D.A. 58(11):4400-4401-A.

WELLS, JUDITH ANN PREECE. 1995. A study of people's attitudes towards plants. University of Missouri-Columbia, 214 pp. Supervisor: Marlin N. Rogers. Order no. DA9823317. D.A. 59(2):478-B.

WILLIAMS, JEFF T. 1996. Recognizing local organizational adaptations to climatic change: The Last Glacial Maximum in Central Europe and the case of Grubgraben (Lower Austria). University of Kansas, 373 pp. Order no. DA9637358. D.A. 58(4):1346-A.

WILLIAMS, PATRICK RYAN. 1997. Disaster in the development of agriculture and the evolution of social complexity in the South-Central Andes. University of Florida, 217 pp. Chair: Michael Moseley. Order no. DA9824172. D.A. 59(2):534-A.

WILSON, WARREN MILAM. 1997. Why bitter cassava (*Manihot esculenta*)? Productivity and perception of cassava in a Tukanoan Indian settlement in the northwest Amazon. University of Colorado at Boulder, 205 pp. Director: Darna L. Dufour. Order no. DA9725803. D.A. 58(3):964-965-A.

WÖCHERL, HELGA. 1997. The role of faunal resources in subsistence practices during the transition to sedentism and agriculture in south-eastern Arizona. The University of Arizona, 465 pp. Directors: Mary C. Stiner; Paul R. Fioh. Order no. DA9814355. D.A. 58(11):4324-A.

WOOTEN, STEPHEN R. 1997. Gardens are for cash, grain is for life: The social organization of parallel production processes in a rural Bamana village (Mali). University of Illinois at Urbana-Champaign, 381 pp. Adviser: Alma J. Gottlieb. Order no. DA9737293. D.A. 58(6):2276-A.

YOKELL, CAROL A. 1997. Modeling socioeconomic evolution and continuity in ancient Egypt: The value and limitations of zooarchaeological analyses. University of Illinois at Urbana-Champaign, 324 pp. Adviser: Douglas J. Brewer. Order no. DA9812817. D.A. 58(10):3972-A.

YOUNG, STEPHEN SLOCUM. 1997. The use of coarse-grain, global-scale remote sensing data to analyze forest cover, extent and change, in China, 1982-1992. Clark University, 255 pp. Order no. DA9729027. D.A. 58(4):1401-A.

ZHAO, ZHIJUN. 1996. Rice domestication in the middle Yangtze region, China: An application of phytolith analysis. University of Missouri-Columbia, 303 pp. Supervisor: Deborah M. Pearsall. Order no. DA9823337. D.A. 59(2):534-535-A.

ZIMMERMAN, LAURIE SUE. 1997. Dietary reconstruction and subsistence strategies of prehistoric hunter gatherers of the Texas Gulf Coast. Texas A & M University, 281 pp. Co-Chairs: Vaughn M. Bryant, Jr; D. Gentry Steele. Order no. DA9815871. D.A. 58(11):4324-A.

APPENDIX

BRADLEY, JOHN JAMES. 1997. Li-Anthawirriyarra, people of the sea: Yanyuwa relations with their maritime environment. Ph.D. Dissertation, Northern Territory University, Darwin, 511 pp.

SMITH, A. 1987. An ethnobiological study of the usage of marine resources by two Aboriginal communities on the east coast of Cape York Peninsula, Australia. Ph.D. Dissertation, James Cook University of North Queensland, Townsville.

SOSELISA, HERMIEN LOLA. 1995. A place of fish: Subsistence and production for the market in Garogos Island, Maluku, Indonesia. M.A. Thesis, Northern Territory University, Darwin, 233 pp.

BOOK REVIEWS

Los Nombres de los Hongos y lo Relacionado con ellos en América Latina. Introducción a la Etnomicobiota y Micología Aplicada de la Región: Sinonimia Vulgar y Científica. Gastón Guzmán. Xalapa, Veracruz: Instituto de Ecología, A.C., Apartado Postal 63, 91000 México. Pp. Xx, 357, five color paintings, three color photographs, 27 B/W illustrations, 19 B/W photographs, four appendices, 24pp bibliography of 486 references, no index. US$30.00; MN$200.00 in Mexico (sew-and-glue paperback); US$50.00, MN$300.00 in Mexico (Smythe-sewn hardcover); all prices postpaid. ISBN 968-786306-4.

Gastón Guzmán is one of the pioneers of Mexican mycology. He participated in the scientific rediscovery of the psilocybian mushrooms in 1957 as a student field-assistant to German mycologist Rolf Singer and later became the leading authority on their taxonomy. He wrote the monographic treatment of the genus *Psilocybe* (Guzmán 1983) and has now produced an encyclopedia of Larin American ethnomycology. Guzmán was originally inspired by the seminal ethnomycological studies of Valentina P. and R. Gordon Wasson, which led to the rediscovery of the sacred mushrooms in Mexico in 1955 (Wasson and Wasson 1957). He has long been a leading exponent of the field in his native Mexico, in many respects a living laboratory of ethnobotany. The present volume is a well-produced and sturdily-bound ethmomycological dictionary, featuring some 5500 entries of vulgar names for fungi, of which some 3,400 are Mexican; another 1000 general to Latin America. These entries encompass some 1750 species (70 Phymycetes; 300 Ascomycetes; 800 Basidiomycetes; 450 Deuteromycetes; 8 Myxomycetes; and 115 1ichens), and a 45 page appendix 1ists these by families in alphabetical order, with full author citations (three previous appendices list Mexican ethnic groups and their locations; vulgar- and scientific-name synonymy of plants parasitized by fungi cited in the text; and fungal genera with families). The extensive bibliography gives full references to all citations, and a brief introduction explains the book's structure and source material. Five color paintings (counting the cover illustration; four of which are by Verónica Guzmán) grace this atractive book, basically an alphabetical dictionary, and there are 23 full-page plates with line-drawings of some dozen species each, along with black-and-white and color photographs of especially important species. Each entry gives the vulgar name in boldface, followed by parentheses indicating information on category, geography, and/or ethnic group, then the definition, usually paragraph-length, with bibliographic citations and numerous cross-refrences to other entries, also in boldface. Each entry is preceded by one of 11 graphic symbols: 1) edible species; 2) poisonous species; 3) sacred (hallucinogenic) mushroom: 4) mushroom of non-sacred ethnomycological import; 5) ethnomedicinal species; 6) species of chemical or biotechnological interest; 7) miscellaneous species; 8) phytoparasitic species; 9) zooparasitic species; 10) entomoparasitic species; and 11) unknown. This superb feature allows one interested in a particular category efficiently to scan the book to cull out nuggets of salient information. Withal, we have here handy access to a wealth of information of interest to ethnobotanists, agronomists, mycologists, phytochemists, anthropologists, and linguists, all of whom owe Guzmán a debt of gratitude for

this painstaking work. Moreover, the book is quite nicely produced at a very modest price — a bibliographic bargain by any measure, and as such is highly recommended.

LITERATURE CITED

GUZMÁN, GASTÓN. 1983. The Genus *Psilocybe*: A Systematic Revision of the Known Species. J. Cramer, Vaduz, Germany.

WASSON, VALENTINA. P. and R. GORDON WASSON. 1957. Mushrooms, Russia and History (two volumes). Pantheon Books, New York, New York.

Jonathan Ott, President
Natural Products Co.
Apartado Postal 532
Xalapa, Veracruz, México

Gli Allucinogeni nel Mito: Racconti sull'Origine delle Piante Psicoattive [Hallucinogens in Myth: Origin Stories of Psychoactive Plants]. Giorgio Samorini. Torino, Italia: Nautilus, 1995. Pp. 172. Lire 20,000 (sew-and-glue paperbound); 25 B/W illustrations; 13 pp. notes; 12 pp. bibliography of 201 sources; no index). Not copyrighted; no ISBN.

Italian ethnopharmacognosist and psychotropic plant specialist Giorgio Samorini has compiled a fascinating and useful volume of origin myths of 19 psychoactive plants or plant categories. Following a brief introduction describing the historical and geographic scope and cultural importance of this often-overlooked aspect of ethnomedicine, Samorini proceeds to detail a half-dozen Amazonian myths relating to the origin of *yajé* or *ayahuasca*, famed complex of pan-Amazonian visionary potions based on aqueous infusions of stems of the malpighiaceous liana *Banisteriopsis caapi* (Spruce ex Grisebach) Morton and numerous psychotropic and other medicinal plant "admixtures" (Ott 1994). Background information reviewing the history, ecology, and entheobotany of the source plant precedes the elaboration of the relevant myths, themselves set off neatly in italic type from the author's erudite intercalated commentary. *Peyotl* (the mescaline-rich Mexican cactus *Lophophora williamsii* (Lem.) Coulter) is also examined in similar detail under the same format (Anderson 1980); followed by *Cannabis* spp. or marijuana/hashish (Mechoulam 1973); a chapter on Solanaceae, subdivided into *Datura* spp., mandrake or *Mandragora* spp. and tobacco or *Nicotiana* spp., the prototypical and most important New World shamanic inebriant (Ott 1993). A brief chapter outlines major groups of inebriating South American snuffs and gives a Desana myth of the origin of *vihó* snuff (Reichel-Dolmatoff 1975), based on myristicaceous *Virola* spp.; plus Barasana and Yanoamá variants. There is a detailed chapter of myths relating to *iboga* (powdered root of the apocynaceous *Tabernanthe iboga* Baillon), the Pygmy entheogen which has become the focus of the syncretic Bwiti religion in Equatorial West Africa, on which Samorini has conducted field research, including surviving the full initiation, a sort of near-death experience provoked by sub-lethal doses of *iboga* (Samorini 1993). There follow brief chapters on mythology associated with the pan-Andean *San Pedro* cult (aqueous potions containing the mescalinic cactus *Trichocereus pachanoi* Britton et Rose) (Joralemon and Sharon

1993) and *vinho da jurema* (aqueous infusions of roots of *Mimosa tenuiflora* (Willdenow) Poiret and other Leguminosae) of Atlantic coastal Brazil (Ott 1993). Samorini then treats in more detail the Polynesian potion *kava* (aqueous suspensions of rhizomes of the piperaceous *Piper methysticum* Forster *fil.*) (Lebot *et al.* 1992) and psychoactive fungi, the latter divided into two subgroups: *Amanita muscaria* (L. ex Fr.) Persoon ex Gray (Wasson 1968) and "other" (i.e., psilocybine-containing) mushrooms (Ott and Bigwood 1978). The book's focus then shifts from visionary plants to primarily ludible inebriants. There is a chapter on "Stimulant Plants," subdvided into four sections: 1) *coca* (cocaine-rich leaves of *Erythroxylum* spp.); 2) coffee (caffeinated, roasted seeds of *Coffea arabica* L.); 3) tea (caffeine-containing leaves of *Camellia sinensis* (L.) Kuntze) and 4) cola (African nuts of *Cola* spp., also rich in caffeine). The book concludes with a chapter on "Alcoholic Plants and Beverages," having two short subsections, "The Vine and Wine" (our familiar *Vitis vinifera* L.) and "Maguey and Pulque" (*pulque,* wine made from juice of *maguey, Agave* spp. in Mexico, from which *mezcal,* including *tequila,* is now distilled). Samorini gives little space to this aspect, but notes correctly that ancient wines were a sort of "mother liquor" for maceration of "leaves, roots or seeds of hallucinogenic (and other psychoactive) plants," citing the famous Homeric soporific and grief-assuaging *nepenthes,* Helen's opiated wine of the *Odyssey.* Although the beer portion of this equation was recently ably addressed by Christian Rätsch (*vide* review of *Urbock,* this issue), a study of psychotropic wine additives remains a *desideratum* of visionary ethnopharmacognosy. Samorini's book includes 13 pages of end-notes to an eclectic 12 page bibliography of 201 sources. There is a signature insert with 25 pages of black-and-white illustrations of plants, their preparation, use, and artistic representation. Unfortunately, while interesting, these reproductions are of poor quality, not at all in keeping with the overall high quality of typography, graphic design, binding, and paper. The publisher would have done better to eliminate half or all of these pages of illustrations, failing rendering them in a style commensurate with the rest of the book. Better still, these might have been substituted with a much-needed index. It is unconscionable that a high-quality, scholarly book containing so much valuable and interesting information from so many recondite sources — meticulously referenced and documented by the author, one of the world's leading experts on entheobotany — lacks even a rudimentary subject index, and this oversight vitiates the value of the book as a reference for specialists and laypersons. I earnestly hope that in a subsequent edition this grave deficiency will be remedied.

LITERATURE CITED

ANDERSON, EDWARD F. 1980. Peyote: The Divine Cactus. The University of Arizona Press, Tucson, Arizona.

JORALEMON, DONALD and DOUGLAS SHARON. 1993. Sorcery and Shamanism: Curanderos and Clients in Northern Peru. University of Utah Press, Salt Lake City, Utah.

LEBOT, VINCENT *et al.* 1992. Kava: The Pacific Drug. Yale University Press, New Haven, Connecticut.

MECHOULAM, RAFAEL (Ed.). 1973. Marijuana: Chemistry, Pharmacology, Metabolism, and Clinical Effects. Academic Press, New York.

OTT, JONATHAN. 1993. Pharmacotheon: Entheogenic Drugs, Their Plant Sources and History. Natural Products Co., Kennewick, Washington. Spanish translation, 1996. Los Libros de la Liebre de Marzo, Barcelona, Catalunya, Spain.

OTT, JONATHAN. 1994. Ayahuasca Analogues: Pangaean Entheogens. Natural Products Co., Kennewick, Washington. German translation, 1995. Medien Experimente, Lohrbach, Germany.

OTT, JONATHAN and JEREMY BIGWOOD (Eds.). 1978. Teonanacatl: Hallucinogenic Mushrooms of North America. Madrona Publishers, Seattle, Washington. Spanish translation, 1985. Editorial Swan, San Lorenzo de El Escorial, Spain.

REICHEL-DOLMATOFF, GERARDO. 1975. The Shaman and the Jaguar: A Study of Narcotic Drugs Among the Indians of Colombia. Temple University Press, Philadelphia, Pennsylvania. Spanish translation, 1978. Siglo Veintiuno, Mexico City, Mexico.

SAMORINI, GIORGIO. 1993. Adam, Eve and Iboga. Integration: Zeitschrift für Geistbewegende Pflanzen und Kultur 4:4-10.

WASSON, R. GORDON. 1968. Soma: Divine Mushroom of Immortality. Mouton, The Hague, The Netherlands.

Jonathan Ott, President
Natural Products Co.
Apartado Postal 532
Xalapa, Veracruz, México

Missouri Botanical Garden Library
3 1753 00293 7032

NOTICE TO AUTHORS

The *Journal of Ethnobiology*'s revised "Guidelines for Authors" appears in Issue 16(1) on pp. 124–127. If you need a copy of these Guidelines you may request a copy from the Editor. Careful scrutiny of recent issues of the *Journal* should provide appropriate stylistic models for any manuscript you may wish to submit.

Those submitting manuscripts for consideration for publication in the *Journal* should send two hard copies and one copy on a high density 3.5" diskette in IBM-compatible or Apple format with original camera-ready figures. Manuscripts submitted in inappropriate style and format will be returned.

Manuscripts in English should be sent to:

EUGENE S. HUNN
Editor, *Journal of Ethnobiology*
Department of Anthropology
Box 353100, University of Washington
Seattle, WA 98195-3100 USA
(hunn@u.washington.edu)

Manuscripts in Spanish should be sent to:

ALEJANDRO de AVILA B.
Associate Editor, *Journal of Ethnobiology*
Jardín Etnobotánico, A.P. 367
Oaxaca, Oaxaca C.P. 68000 MEXICO
(serbo@antequera.com)

NEWS AND COMMENTS

Information or commentary intended for the "News and Comments" section of the *Journal* should be sent in the same form as for articles to:

GARY J. MARTIN
News and Comments Editor,*Journal of Ethnobiology*
People and Plants Initiative, B.P. 262, Marrakesh-Medina, MOROCCO
(100427.1260@compuserve.com)

BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from readers of the *Journal*. If you submit a book review for consideration please send two hard copies and one on diskette. Send suggestions, comments, or reviews to:

SANDRA PEACOCK
Book Review Editor, *Journal of Ethnobiology*
School of Environmental Studies
P.O Box 1700, University of Victoria
Victoria, BC V8W 2Y2 CANADA
E-Mail: speacock@office.geog.uvic.ca
Phone: (250) 384-4842; Fax: (250) 721-8985

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Gayle J. Fritz, Department of Anthropology, Campus Box 1114, Washington University, St. Louis, MO 63130-4899 USA. Subscription rates are $60 for institutional subscriptions; $25 for students; $35 for regular individual subscriptions except for Latin America, for which subscriptions are $25. Joint members (with spouse, receiving a single copy of the *Journal*) pay $35. For postage outside of the USA, Canada, or Mexico, add $10. Make checks payable to the *Journal of Ethnobiology*. Defective or lost copies will be replaced if a written request is received within one year of issue. For information on back issues contact Cecil Brown, Department of Anthropology, Northern Illinois University, DeKalb, IL 60115 USA, (815) 753–0246.

CONTENTS

ETHNOBIOTICA v

AUTHOR PROFILES vi

THE HISTORICAL FOUNDATIONS OF ETHNOBIOLOGY (1860-1899)
Daniel Clément 161

THINGS THAT GO *PO* IN THE NIGHT: THE CLASSIFICATION OF BIRDS, SOUNDS, AND SPIRITS AMONG THE NAGE OF EASTERN INDONESIA
Gregory Forth 189

INTERPRETING WILD SEEDS FROM ARCHAEOLOGICAL SITES: A DUNG CHARRING EXPERIMENT FROM THE ANDES
Christine A. Hastorf and Melanie F. Wright 211

TESTING PRAIRIE PLANTS WITH ETHNOBOTANICAL IMPORTANCE FOR ANTI-CANCER AND ANTI-AIDS COMPOUNDS
Kelly Kindscher, Kirk P. Manfredi, Melissa Britton, Maria Demidova, and Dana P. Hurlburt 229

THE ROOTS OF TRADITION: SOCIAL ECOLOGY, CULTURAL GEOGRAPHY, AND MEDICINAL PLANT KNOWLEDGE IN THE OZARK-OUACHITA HIGHLANDS
Justin M. Nolan 249

PLANT FOOD RESOURCE RANKING ON THE UPPER KLAMATH RIVER OF OREGON AND CALIFORNIA: A METHODOLOGY WITH ARCHAEOLOGICAL APPLICATIONS
Donn L. Todt and Nan Hannon 273

RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS XVI
Terence E. Hays 309

BOOK REVIEWS 188, 210, 228, 246, 270, 317, 318