Journal of Ethnobiology

VOLUME 3, NUMBER 1 MAY 1983

JOURNAL ORGANIZATION

Journal of Ethnobiology is published semi-annually. Manuscripts for publication and information for the "News and Comments" section should be sent to the appropriate editor as explained on the inside back cover of this issue.

ISSN 0278-0771

Volume 1, Number 1 — May 1981

CONTENTS

Volume 1, Number 2 December 1981

CONTENTS

Volume 2, Number 1 May 1982

CONTENTS

Volume 2, Number 2 December 1982

CONTENTS

Volume 3, Number 1 May 1983

CONTENTS

Volume 3, Number 2 December 1983

CONTENTS

Volume 4, Number 1 May 1984

CONTENTS

Volume 4, Number 2 December 1984

CONTENTS

Volume 5, Number 1 Summer 1985

CONTENTS

Journal of Ethnobiology

Special Notice

The *Journal of Ethnobiology* is planning to expand to a quarterly publication beginning with Volume 4, 1984. In order to achieve this goal, we must increase membership to at least 500 members, by December 1983. There are currently 275 subscribers. We strongly encourage all members to help us in this task by finding at least two new members each by this deadline. This will benefit all members as it will increase publication space for papers and provide additional information on current research in ethnobiology.

In order to obtain a sufficient backlog of manuscripts to enable the *Journal* to become quarterly, we invite all members to submit publishable manuscripts to the editor. The editorial staff thanks you for your support.

VOLUME 3, NUMBER 1 MAY 1983

SKETCHES IN THE SAND

Saludos. Yo soy sú nuevo editor.[1]

I have observed that writers of this type of column try to nurture, inspire, enlighten, or inform. The safest route is to dwell on the past—recalling some largely mythical golden age and wistfully hoping for its speedy return. The bravest of these are prognosticators, predicting at times gloom and doom and at other times seeing the future as the distillation of "Rebecca of Sunnybrook Farm." Interesting as these predictions are, they usually have about the same degree of accuracy as those of the nation's weather forecasters before satellite photographs. On second thought, predicting the future in an editor's column is safer than interpreting the present: by the time the future arrives, many will have forgotton not only the column but the prediction too! All of the above appears frequently enough in pages of commentary that I wonder if it's a condition editors develop. If so, I suppose you can expect much the same from me. The most risky route is to entertain, and if I had the talent and inspiration I would prefer to do this—intentionally, that is.

For some of you what follows will be useful information; others will consider it an elaboration of the obvious. I think it important enough to include it in these pages, but I'll try to waste as little printer's ink as possible.

The *Journal of Ethnobiology,* with its excellent Editorial Board, has a large number of watchdogs and all of us on the editorial staff are guardians of its standards. I, as well as every subscriber, must charge board members and the reviewers they select, with exacting tasks, e.g., to: (1) identify and reject jargon, with which the literature already may be unreasonably and unnecessarily burdened; (2) eliminate or at least reduce undesirable borrowing from other disciplines, especially the improper application of concepts and research techniques; and (3) maintain scholarship on a sufficiently high level that the *Journal* will enjoy continued esteem. But as important as these tasks are, equally important, and, I think, more challenging, more exciting, and definitely more elusive, is the recognition and encouragement of promising, innovative approaches, that, being preliminary in nature, may not be as well developed as research reports as we might ordinarily expect. It is sometimes through the publication of seemingly skimpy data that an inventive line of investigation is encouraged which may eventually transform a discipline, e.g., the early contribution of pollen analysis to archaeological botany.

Only a few such preliminary investigations can be or should be published and we can hope that we use sound judgment in our selections. This issue is a good mix of botany and zoology, of studies emphasizing contemporary and past events, and of preliminary and continuing investigations. Forthcoming issues can have this desirable combination only if subscribers from all areas of ethnobiology continue to submit publishable manuscripts.

I, as editor, and Karen R. Adams, as Associate Editor, will try to be good and maybe even vociferous watchdogs. We will examine each manuscript to see if an author's assumptions are clearly stated and if arguments are logical and lucid. But in addition to evaluating content, both of us want the *Journal of Ethnobiology* to be not only scholarly but also a pleasure to read. We therefore encourage the use of personal pronouns, the active voice, and verbs of power. We will smile favorably upon papers which utilize dynamic topic sentences to connect a series of concise and well-integrated paragraphs. When appropriate, we expect to recommend revisions to enhance the readability of the text so that even if a given reader has no particular interest in the subject matter of a paper, he or she may at least remain awake!

WV

[1]Spanish for "Greetings. I am your new editor."

J. Ethnobiol. 3(1):1-13 May 1983

THE ROLE OF PLANTS FOUND IN THE MEXICAN MARKETS AND THEIR IMPORTANCE IN ETHNOBOTANICAL STUDIES

ROBERT A. BYE, JR. and EDELMIRA LINARES
Jardiñ Botánico, Universidad Nacional Autónoma de México
04510 México, DF

ABSTRACT.–The availability of plants in the Mexican markets has been important in the past and continues to be important today. These markets can provide much information on the ethnobotanical process of plant-people interactions and relationships. An introduction to our current work is presented. Eleven factors which influence the availability of plants in the "tianguis" market are discussed briefly. Methodologies for the market, the field and the laboratory are outlined. Examples are presented for the following components of the ethnobotanical process: temporal partitioning, spatial partitioning, flow patterns, and ecological and evolutionary factors. Most of the data are derived from the Mercado de Sonora of Mexico City, Distrito Federal (a major market), and from Santa Catarina del Monte, México (a source area). Tentative conclusions are: (1) plants in the markets are the product of intensified interactions between people and plants (e.g., about 75% of the market plants are derived from human altered environments); (2) the actual contribution of the plants from the source area to the major market is considerably below its potential and is related to spatial partitioning of the source areas in the major market; (3) markets will continue to be important in Mexico's future in order to provide the people with alternative choices in the diverse plants and plant products available.

INTRODUCTION

The markets have long been a part of Mexican history. The pre- and early post-Conquest markets of central Mexico have been described by such early observers as Cortés (1981), Diaz de Castillo (1977), and Sahagún (1979) and have been analyzed by contemporary scholars (Garibay 1961; Benitez 1962). In Mexico City, representations of those early market scenes can be seen in Diego Rivera's mural, "El México Precortesiano: Tenochtitlan", located in the Palacio Nacional (Taracena 1981), and in the Museo Nacional de Antropología (Ramírez V. et al. 1968). Peterson (1959:217) credits the market as "one of the most impressive survivals of ancient Mexico". Nearly 400 years later, similar scenes (Fig. 1) can be found throughout Mexico. Many plant species sold or exchanged in the markets of the past are still found today. These markets are fertile grounds for ethnobotanical studies.

The social sciences have benefited from market studies as reviewed by Whitaker and Cutler (1966). To a lesser degree, the biological sciences have benefited from such studies. Botanists of the U. S. Department of Agriculture, such as Edward Palmer (Bye 1979) and J. N. Rose (1899), used markets as a source of information and specimens of useful Mexican plants. Other botanists have discovered new species of edible plants, such as *Chenopodium nuttalliae* Safford (Safford 1918) and *Pinus maximartinezii* Rzedowski (Rzedowski 1964), in some Mexican markets. The importance of markets in tracing the history of cultivated plants and in the analysis of archaeological plant remains is supported by the work of economic botanists, Whitaker and Cutler (1966). These two botanists recognized the untapped wealth of plants in markets and suggested more careful studies. Their comments on the need for "carefully documented collections and records of the markets" (Whitaker and Cutler 1966:6) anticipated our present research.

Ethnobotany can be defined as the study of the biological and ecological bases of interactions and relationships between plants and people over evolutionary time. *Interactions* refer to mutual influences of plants and people upon each other. *Relationships* refer to associations between plants and people which are usually one-sided (e.g., a nomenclatural system of plants when applied by humans has no direct effect upon the plant populations). One focus in ethnobotanical studies is the process of these interactions and relationships.

FIG. 1–Mexican market scenes. (1a): Mercado de Sonora, Mexico City, DF, with a stand of fresh medicinal plants from San Juan Tepecoculco, near Ozumba, México. (1b): Mercado La República, San Luis Potosí, SLP, with a view of the dry medicinal plants. The rolls of small bundles of medicinal herbs are suspended from the ceiling while the cut dried plants are in the sacks on the floor.

Markets represent an intensified interaction between people of different socio-economic groups and special plants. People require plants to fulfill certain biological, cultural and economic needs. When removed from daily contact with the plant sources, people depend upon an organized exchange structure, such as a market, to obtain the plants. The market allows for higher intensity of selection of plants (due to economic constraints) and eventually leads to more intensified interactions between the plant populations and the people in direct contact with the plants. In addition, the presence of plants in the market over long periods of time suggests that these plants produce effects which are expected by the consumers. As a result, pressure on certain plants and plant populations is increased. Certain plants are continually tested, evaluated, and demanded because of their recognized values, properties, and effectiveness.

METHODS

The methodology that is used to obtain the information at various markets varies depending upon local conditions. Because this paper deals mostly with the Mercado de Sonora in Mexico City, we will describe the methodology we use there.

Market.—The focus of the study is on fresh plants that are sold for medicinal and/or food purposes. These are collected on a regular basis. In some cases, dry plants are also acquired. During certain seasons, plants for other purposes (e.g., ornamental) are collected. Each week, a visit is made to the market early in the morning. The day of the week varies. The "días de plaza" in Mercado de Sonora when there are more vendors are Tuesday and Friday. Information on the plants present and their condition is recorded. Also for each plant collected, information is requested from the vendor and is recorded in notebooks and with a tape recorder (when possible). The information includes: (a) plant name(s); (b) purpose(s) and use(s); (c) preparation(s); (d) qualities (e.g., "hot", "cold", flavor, etc.) attributed to the plant; (e) source area; (f) whether the plant is gathered or cultivated; (g) type of plant community and habitat from which the plant came; (h) price of the unit purchased; and (i) type of vendor (e.g., resale vendor, collector-vendor, etc.). If consumers are present, we also ask questions related to points a, b, c, and d above.

In order to document the plants, three steps are taken. First, specimens (usually in the units (e.g., "manojos" or handfuls) that they are sold normally) are purchased after bargaining the price. The material that can be pressed in a standard plant press is made into herbarium specimens. Bulky material is dried or placed in a liquid preservative and is called a case specimen. Both types of specimens serve as original voucher material.

Second, in the case of seeds, stems, and roots, additional material is purchased for propagation. The propagation specimen is grown to produce more taxonomically important parts (e.g., flowers) and to serve as the basis for making a corroborative voucher specimen (Lee et al. 1982).

The propagation specimen is used to increase the number of plants, which are then integrated into the living collection of the Jardín Botánico, Universidad Nacional Autónoma de México (UNAM).

Third, color slides and black and white photographs are made of the market specimens and living collections.

Field.—After contacts are made with collectors and vendors in the major market, visits are made to the field and to local markets. The purpose of these visits is to identify the areas and the plant populations from which the market plants are derived. Information and documentation with specimens and photographs from the field are similar to the points outlined above for markets. In some cases, the herbarium specimens from the field can serve as corroborative specimens for the market specimens. In addition, local ethnobotanical and ecological information is recorded.

Laboratory.—The specimens are identified using the available literature and the specimens in the Herbario Nacional (MEXU) of UNAM. Duplicate specimens of certain groups are sent to taxonomic specialists for verification. Each specimen carries that information gathered in the market or in the field.

Proper deposition of the documentation material is important. The first set of original voucher specimens and corroborative voucher specimens is deposited at MEXU. Duplicate specimens are exchanged with other herbaria. Living collections are part of the Jardín Botánico, UNAM. Photographs and notes (from notebooks and transcripts) are deposited in the Jardín Botánico, UNAM. Materials for analysis and experimentation are collected for collaborating institutions interested in anatomical, chemical and nutritional studies. These materials have associated voucher specimens.

PLANTS IN MARKETS

Many supply and demand factors affect the presence of plants in the markets. These basic factors are subject to biological and ecological influences.

Factors on the supply side that are of our interest are:

(1) The availability of fresh plants (Fig. 2a) in the catchment area (i.e., the area from which the plant originates and can be transported to the main market without loss of its properties). These plants may be gathered from wild populations or from anthropogenic populations. Also, these plants may come from cultivated populations of non-domesticated or domesticated plants.

(2) The availability of dry plants from previous harvests (usually in small bundles or loose pieces; Fig. 2b, 2c). These processed dried plants are made from seasonally fresh material from the catchment area and stored. They can be sold when the fresh plants are not available. Also, these dried plants are imported from areas outside the catchment area. They are dried in fragments or small bundles which allow for easy transport and sale in large quantities.

(3) The compensation. The financial or other returns that the collectors and vendors receive must compensate their expenses. Also some plants may or may not be gathered and sold due to ethical reasons (e.g., "toloache" *(Datura stramonium* L.) is considered by some people to be a plant of the devil and because of this is not sold by them, or it is sold with certain precautions).

Factors on the demand side that are of our interest are:

(1) The fulfillment of certain purposes, such as medicinal and edible plants that are part of certain social practices, ethnic beliefs, or customs. "Muitle" *(Jacobinia spicigera* (Schlecht.) L.H. Bailey) is drunk as an invigorating tea by outdoor laborers; "papitas" *(Solanum* spp.) and "romeritos" *(Suaeda diffusa* S. Watson) are frequently eaten during the Lenten season; and "gordolobo" *(Gnaphalium* spp.) is consumed as a tea to alleviate coughs.

(2) A satisfactory level of effectiveness. The plant or plant product produces results which are acceptable to the consumers.

(3) The economic price. The plant is affordable by the consumers.

(4) The alternatives. If certain plants or their products are not available due to seasonality, limited supply, or unaffordability, other plants can be used as substitutes. Thus choices or options are available to the consumers. Certain plants may be preferred under specific conditions while others are used at different times.

(5) The standard plants all year round. Certain edible plants, such as "nopal" *(Opuntia* spp.), ritual cleansing plants, such as "piru" *(Schinus molle* L.), and medicinal plants, such as "manzanilla" *(Matricaria chamomilla* L.), are in demand all year round and are usually in constant supply all the time.

(6) The standard plants by seasons. Other plants may be needed on a seasonal basis. "Fresno" *(Fraxinus* spp.), a "cool" plant, is consumed more during the warm season when the leaves are also available.

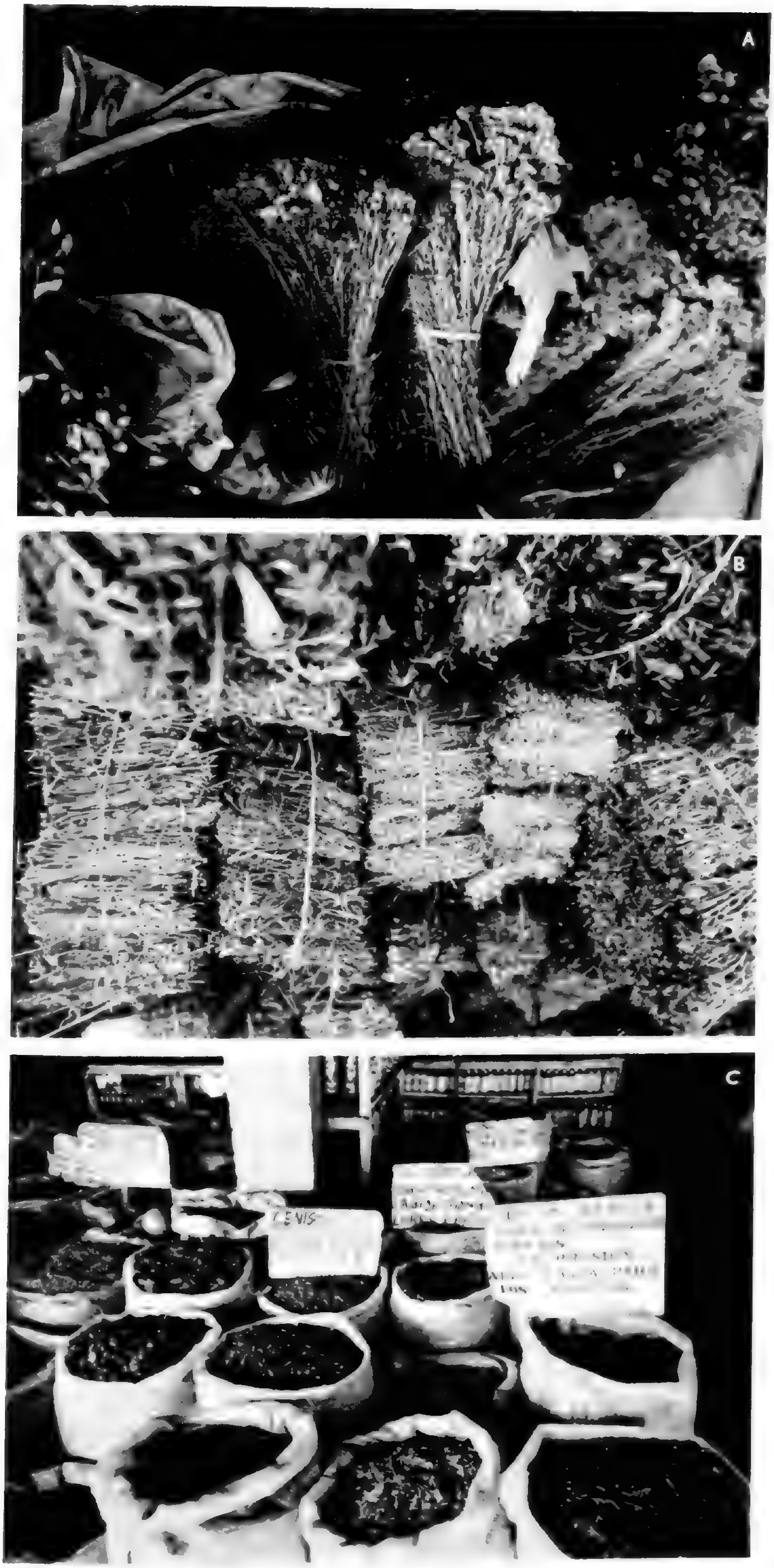


FIG. 2–Forms of medicinal plants found in the markets. (2a): Bundles ("manojos") of fresh plants (*Tagetes lucida*, *Gnaphalium* sp., and *Chenopodium graveolens*) in Mercado de Sonora, Mexico City, DF. (2b): Small bundles ("manojos") of dried medicinal herbs tied into rolls in Mercado La República, San Luis Potosí, SLP. (2c): Sacks of pieces of dried medicinal plants in Mercado La República, San Luis Potosí, SLP.

(7) The requested plants. Some plants are sought specifically because of their properties. "Ortiga ancha" *(Urtica dioica* L.) from Ozumba, México, is requested by a spiritualist for ritual cleansing and bathing because the plants from this region are said to be more "carnivorous" than plants from other regions.

(8) The opportunity. Plants which the collector/vendor happens to include in his/her stand for no specific reason may be of interest to the consumers. Also, the consumers may be looking for new plants to try. Thus, the choice for a particular plant may be a matter of unexpected demand.

CATEGORIES

Many categories of plants can be identified in the market. Artificial divisions are often made by ethnocentric uses such as edible, condiment, medicinal, religious, and ornamental. Although some markets and some stands may be labeled as specialist in one use category or another, our studies indicate that any one stand contains plants of two or more artificial divisions. Also, a plant, such as "pericón" *(Tagetes lucida* Cav.), may be considered a food additive by one consumer, a medicine by another, and an important element in religious rituals by a third.

The parts of the plants (Fig. 3) found in the market are also other variables in assigning categories. They may include: edible fungi[1]; medicinal ferns, e.g., "culantrillo" *(Adiantum capillus-veneris* L.); medicinal roots, e.g., "matarique" *(Senecio peltiferus* Hemsley); medicinal steams, e.g., "tumba vaquero" *(Cissus sicyoides* L.); condiment leaves, e.g., "hoja santa" *(Piper auritum* HBK.); edible leaves, e.g., "quelite cenizo" *(Chenopodium berlandieri* Moq.); medicinal flowers, e.g., "flor de manita" *(Chiranthodendron pentadactylon* Larr.); edible and medicinal fruits, e.g., "xoconochtle" *(Opuntia,* subgen. *Opuntia);* and magical seeds, e.g., "colorín" *(Erythrina* spp.).

PROCESS

We would like to consider some, but not all, the components that make up the ethnobotanical process in the Mexican markets. Although our studies cover various parts of the country, we will use data from one of the most important markets located in Mexico City. From this and other markets we plan to prepare some generalizations about the ethnobotanical process of markets and to construct hypotheses that can be tested in other markets.

The Mercado de Sonora is located in the large and old La Merced complex in central Mexico City (Valencia 1965; Ryesky and Paniagua 1979). It is a "tianguis" market where the plants are sold by individuals or families. These vendors often gather the plants from the fields and towns (e.g., Ozumba, Ajusco, Santa Catarina del Monte) in the mountains surrounding the city (Mexico City is on the trans-volcanic mountain belt of south-central Mexico). The potential vegetation of the areas is coniferous-oak forests and grasslands (Rzedowski 1978). It is located in the basin of the Valle de México which is surrounded by volcanic peaks. Our studies in the Mercado de Sonora were initiated in May 1981 and were intensified in September 1981. A complete list of the species of plants encountered in our market studies is not reported here. Future publications will present more details on the plants and their ethnobotanical importance.

Temporal partitioning.–The presence, richness, and abundance of plants vary with time of day, day of the week, and season of the year (Fig. 4). Some cultivated plants, such as the edible "nopal" *(Opuntia* spp.), and the cultivated and adventive plants such as "pirú" *(Schinus molle* L.), a common base for "ramos" for ritual cleansing, are available and abundant year round. "Flor de manita" *(Chiranthodendron pentadactylon* Larr.), a highly prized and effective heart remedy, is available fresh during the winter months. Leaves of "fresno" *(Fraxinus* spp.) are considered "cool" and are used in baths. They are found in the market during the warm late spring and early summer months. "Pericón" *(Tagetes lucida* Cav.), an aromatic herb used as a food additive in maize dishes and

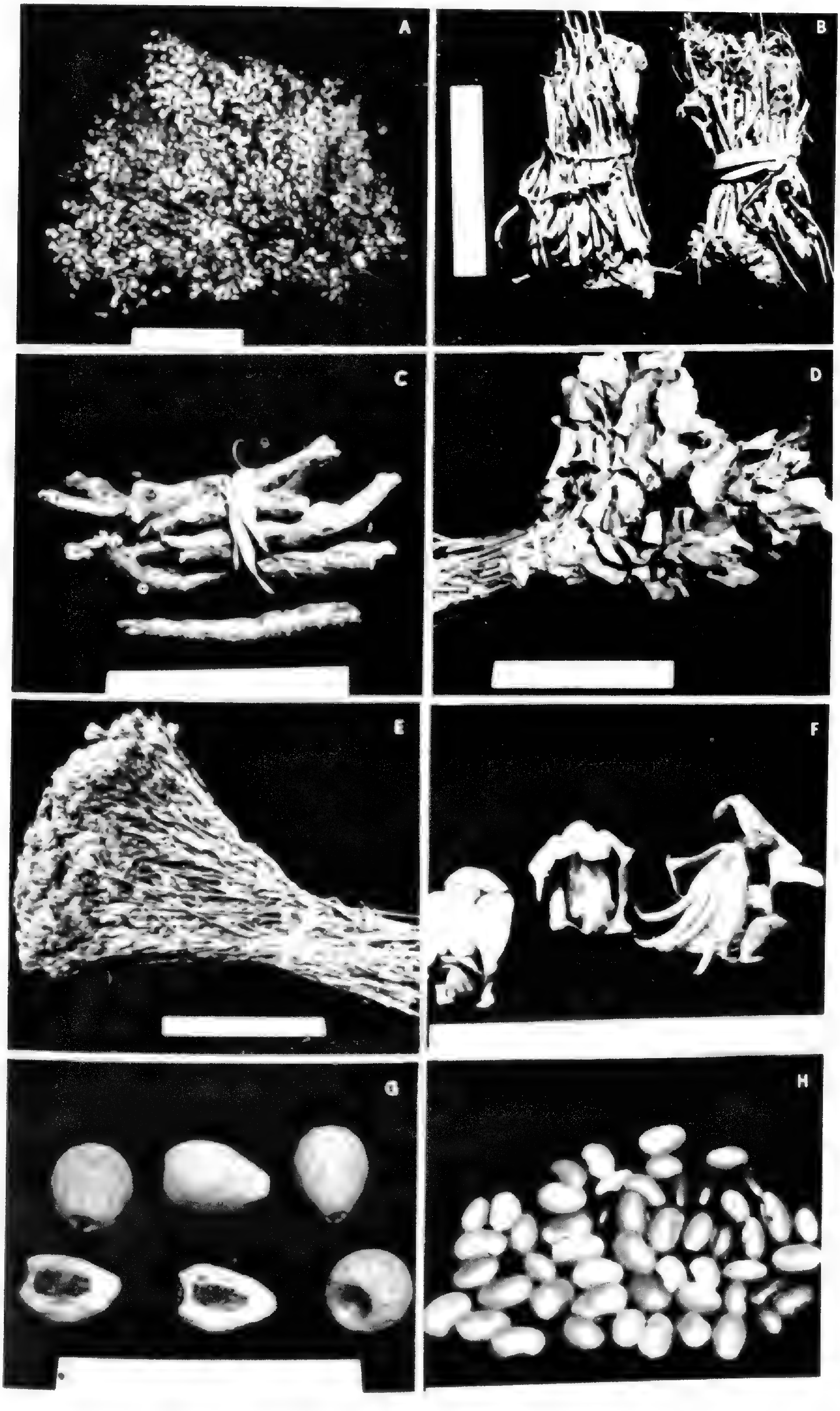


FIG. 3.–Examples of some market plants. The white scale is equal to 15 cm. The number following each name refers to the Bye & Linares collection number of the voucher specimen. (a): *Adiantum capillus-veneris* (11,031); (b): *Senecio peltiferus* (10,286); (c): *Cissus sicyoides* (10,726); (d) *Chenopodium berlandieri* (10,596); (e) *Tagetes lucida* (10,541); (f): *Chiranthodendron pentadactylon* (10,252); (g): *Opuntia*, subgen. *Opuntia* (10,962); (h): *Erythrina* sp. (10,733).

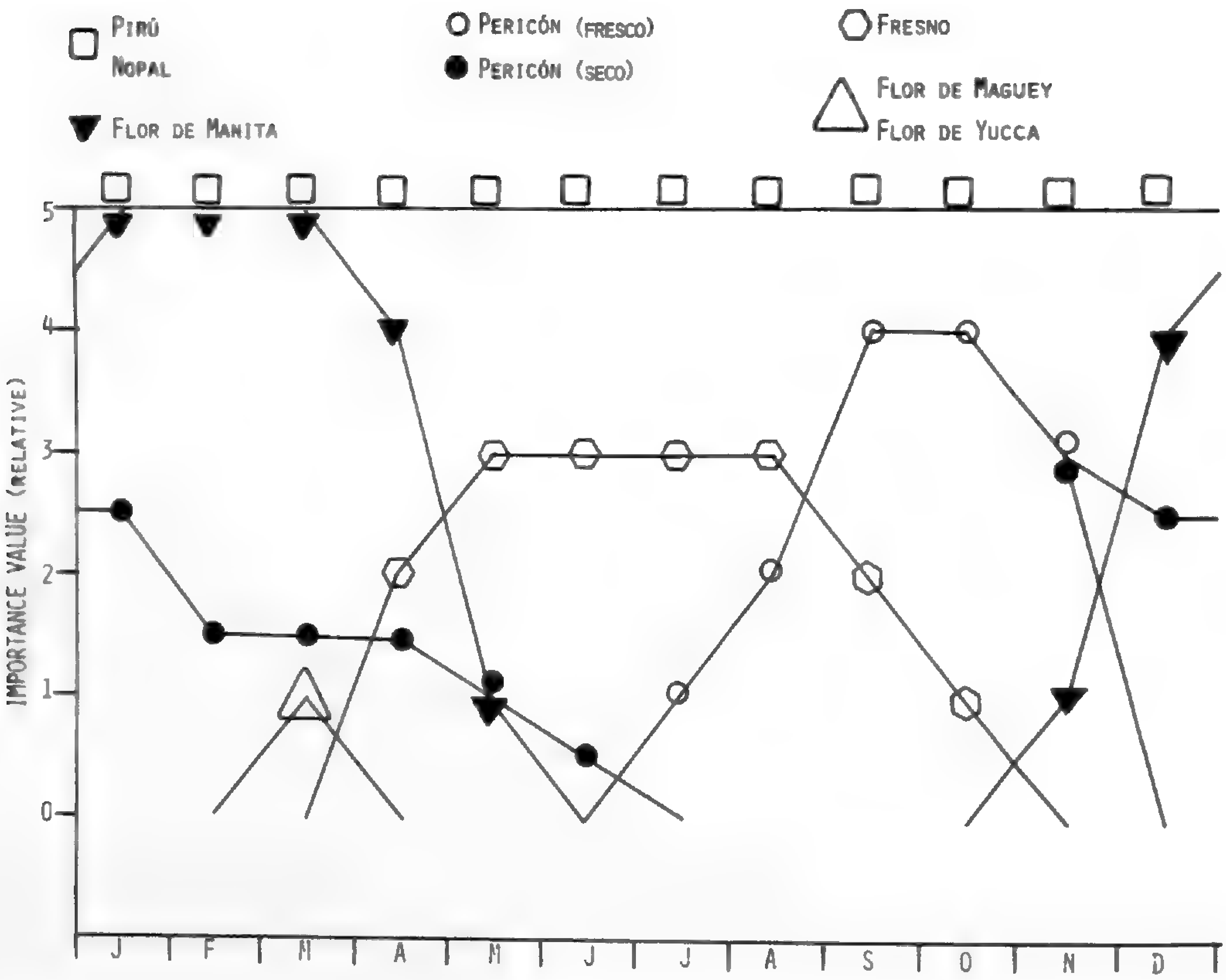


FIG. 4.–Temporal partitioning of some plants in the Mercado de Sonora, Mexico City. The importance value is relative and ranges from 0 (absent) to 5 (abundant). The year is divided into months from January (J) through December (D). The symbols are: open square (□): *Opuntia* spp. and *Schinus molle;* inverted, filled triangle (▼): *Chiranthodendron pentadactylon;* open triangle (△): *Agave* spp. and *Yucca* spp.; filled circle (●): fresh *Tagetes lucida;* and open hexagon (⬡): *Fraxinus* spp.

consumed as a tea to treat stomach aches, is a summer and early fall flowering herb which is available fresh during that period. Bundles also are dried and sold during the rest of the year. Not all plants have such long durations in the markets. The edible flowers of "maguey" *(Agave* spp.) and "yuca" *(Yucca* spp.) are available only during the few weeks of spring.

Spatial partitioning.–Variations in the presence, richness, and abundance of plants also occur over space. Some types of plants are grouped in one section of the market while other types of plants are seldom seen in nearby stands but are dispersed throughout. Another type of spatial partitioning is the geographic distribution of the source areas of the plants in the market. Although many of the plants grow in all the major source areas, only a part of the plants come from one area while other plants come from other areas.

The 150 medicinal plants found in the Mercado de Sonora are compared with the 114 medicinal plants of Santa Catarina del Monte, which is located about 50 km to the east in the state of México. There are 85 species that are common to both the main market and this source area. These 85 plants represent the *potential* contribution of Santa Catarina del Monte to the Mercado de Sonora, i.e., ca. 57% of the plants sold in this main market could come from this one source area. However, the *actual* contribution of medicinal plants from Santa Catarina del Monte to the Mercado de Sonora is only 38 species, i.e., ca. 25% of the plants sold in the main market come from this particular source area. The other plants come from other source areas.

Flow patterns.–The process of flow of plants from the source plant populations to the ultimate consumer can reveal many biological and cultural factors which are important in plant-people relationships and interactions. Our initial attempt to identify the path of movement of plants is presented in Fig. 5 and 6. Our objectives include: (1) the

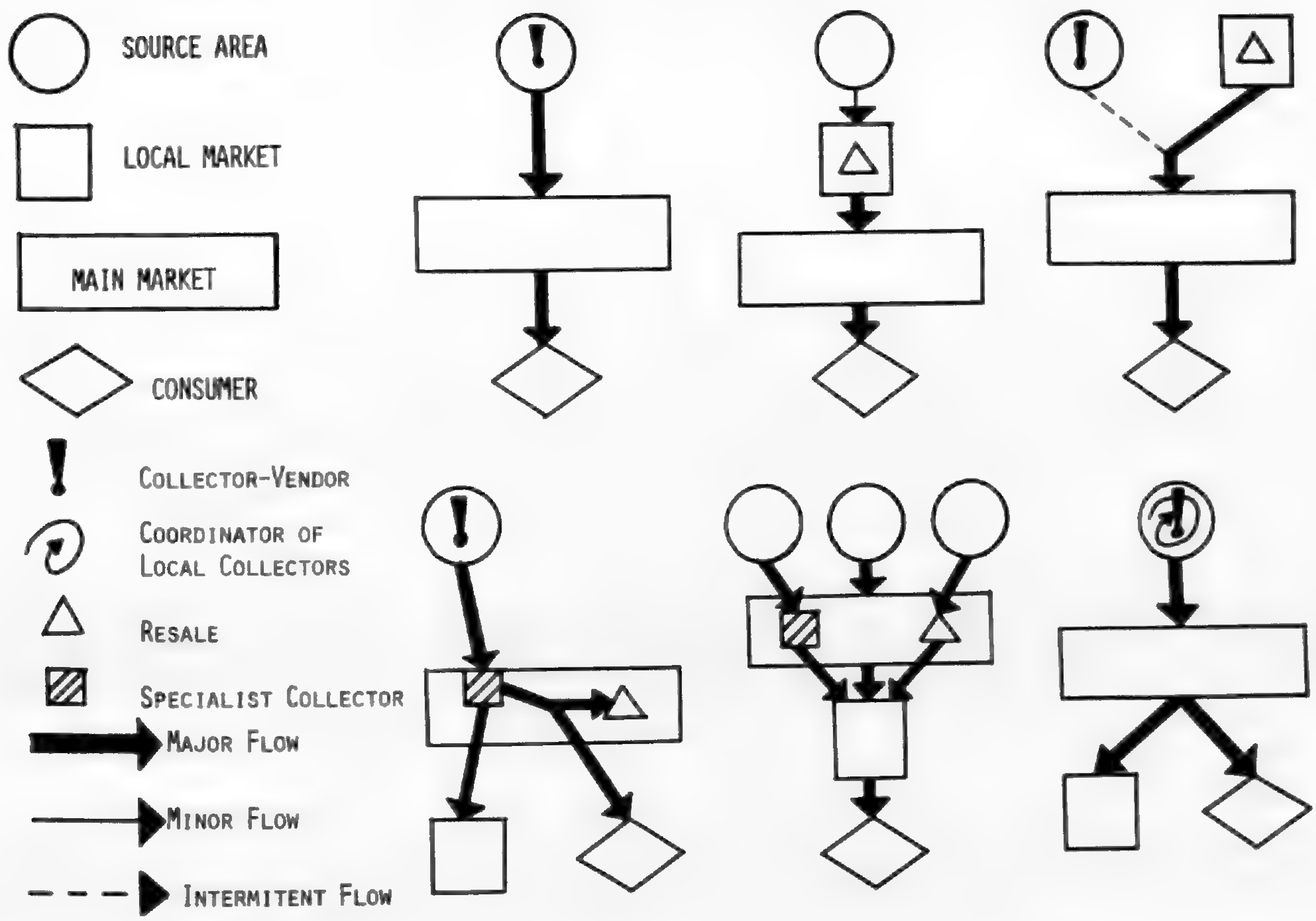


FIG. 5.–Six common flow patterns of market plants with explanations of the symbols.

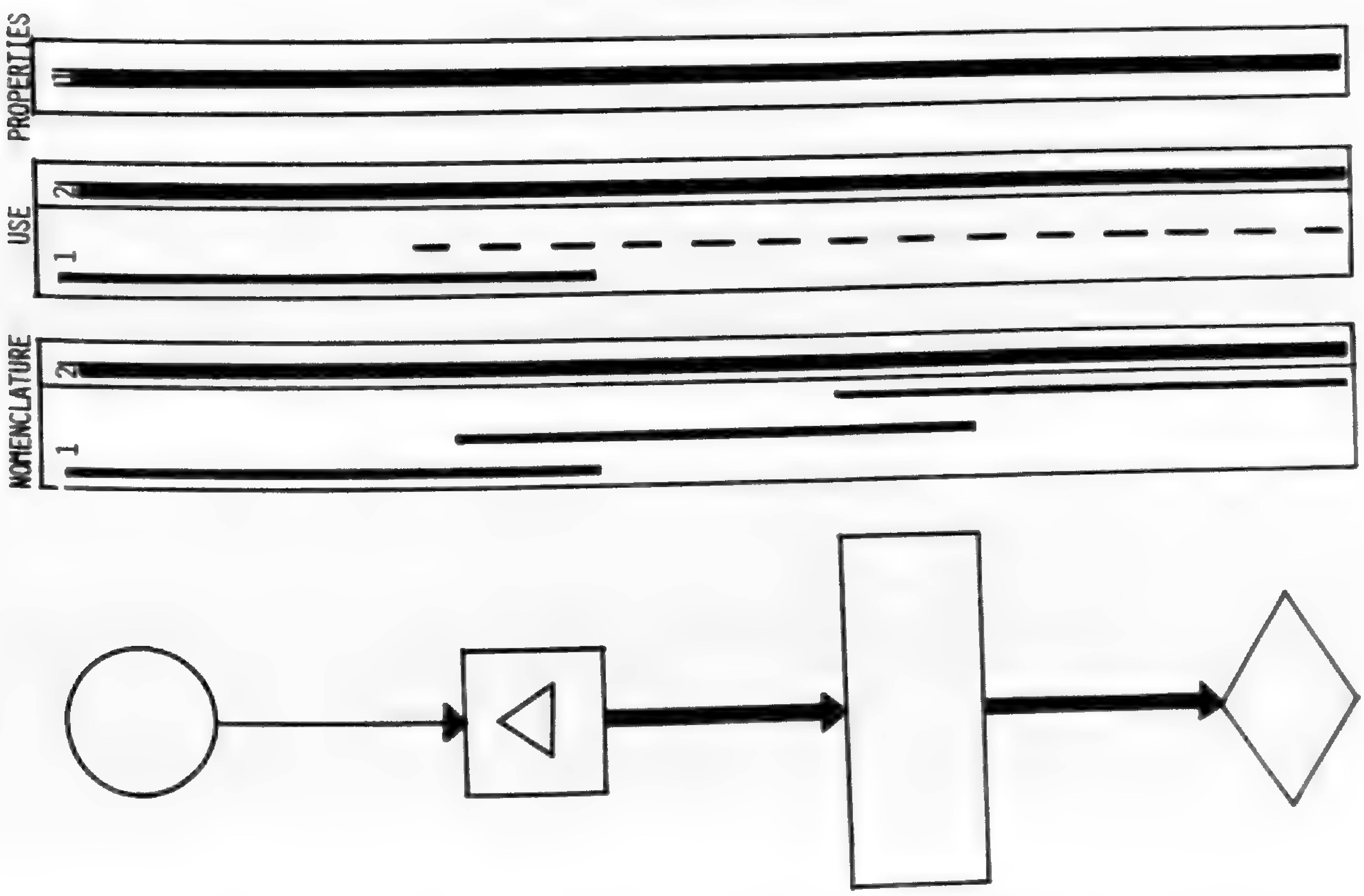


FIG. 6.– A common flow pattern of market plants illustrating the discontinuity and the continuity of information on nomenclature, use, and properties.

identification of the source plant populations and the associated gathering practices which may have ecological and evolutionary influences on the populations, and (2) the evaluation of the variation and reliability of the information on the relationships and interactions of the plants with reference to the experiences of (a) the collectors, (b) the vendors, and (c) the consumers. A common flow pattern is presented in Fig. 6. It illustrates how we plan to evaluate our data with reference to continuity and discontinuity of information on nomenclature, use, and properties of the plants at different levels of the flow process.

Case 1 of nomenclature shows discontinuity in that the names used at different levels between the source area and the consumer are different. Although the same plant may be desired, the resale vendor must be aware of the different names. He/she provides an important link in our comparative study of the same plants among different peoples. Two examples include: (1) *Eupatorium collinum* DC.: in San Juan Tepecoculco, México, it is called "yerba de burro" while it is sold in the Mercado de Sonora as "yerba de angel"; (2) *Satureja macrostema* (Bentham) Briq.: in Santa Ana Tlacotenco, DF, it is called by its Nahuatl name, "tiochil", while in the Mercado de Sonora it is sold under the name, "té del monte". Case 2 of nomenclature illustrates continuity where the name applied to the plant is the same throughout the exchange.

Case 1 of use illustrates a pattern of discontinuity where the use may be known at the source area level but is not known further down the chain. The vendor is unaware of the plant's use but sells it because of the continued demand. Also, some of our "quien sabe" responses at the vendor or consumer level may be due to the prohibition of sale or use of the plant (e.g., the sale of "zoapatle" *(Montanoa tomentosa* Cerv.), an abortive, is subject to a fine of $10,000 pesos). Case 2 of use shows continuity where the use of the plant is the same throughout the system.

Case 1 of properties which may be attributed to the plant (e.g., "hot", "cold", taste, nutritional quality, etc.) is continuous.

Ecological and evolutionary factors.—There are many ecological and evolutionary factors in the ethnobotanical process associated with market plants. Two examples include:

(1) Gathering habitats. Plants can be derived from gathering habitats which have wild populations or anthropogenic populations (i.e., those which are responses to human disturbances). Plants can also be derived from cultivated habitats which have non-domesticated plants or domesticated plants (i.e., plants that are genetically altered due to human selection).

Ecological analysis of the medicinal plants from Santa Catarina del Monte, Mexico, recorded by González R. (1981) and by Bye and Linares (in progress) is summarized in Table 1. About 75% of the medicinal plants come from human manipulated habitats (i.e., anthropogenic and cultivated environments). Over 81% of the Santa Catarina del Monte plants sold in the Mercado de Sonora are collected from this modified environment. The modification of the habitats as well as the genetic selection and maintenance of certain plant populations represent intensified interactions between plants and people. About 25% of the medicinal plants are derived from the wild habitats.

(2) Condition of the plant. The morphological and chemical condition of the plant in the markets is based on certain ecological and evolutionary factors among others. For instance, "jarilla" *(Senecio salignus* DC.), which is considered a "fresh" plant and is used for baths, is commonly sold in the markets in the vegetative stage. This plant is found in the native habitat of forest openings as well as in the anthropogenic habitats near and inside the town. Although it is found in the forest, the collectors obtain their material from the plant populations near the town. Leafy branches are cut throughout the growing season. Even during the flowering season (February through April), the market plants are usually without flowers. This non-flowering condition reflects two factors. First, the vegetative state is considered to be more effective than the flowering state. Second, the collected plants tend to be more leafy and with fewer flowers than the plants in the

TABLE 1.—*Ecological analysis of medicinal plants from Santa Catarina del Monte, México.*

HABITATS	GATHERED		CULTIVATED	
Plant Populations	Wild	Anthropogenic	Non-domesticated	Domesticated
Total: 114 species (González R., 1981; Bye & Linares)	28	52	2	32
Sold in Mercado de Sonora, DF: 38 species (Bye & Linares)	7	12	2	17
Market plants: Recorded in González R. (1981): 23 species	3	10	2	8
Additional plants recorded by Bye & Linares: 15 species	4	2	0	9

natural communities. Often the leafy shoots represent coppice sprout growth—a response to continued cutting. Thus the effectiveness and the plant's response to gathering practices are related to the morphological and possible chemical conditions of the plant in the market despite the general phenological pattern of the natural populations.

CONCLUSIONS

Although the study is still in progress, we can make some general conclusions. First, the "tianguis" market system is still important in Mexico today, as it was in the past. Second, the markets of Mexico can provide much data for ethnobotanical studies from various points of view. Third, the plants in the market represent the intensification of interactions and relationships between people and plants. A majority of the medicinal plants of the Mercado de Sonora is derived from the human-modified environment. Fourth, the diversity of edible and medicinal plants of the market will be important in Mexico's future because the exchange system allows for alternative choices of plants and plant products which have multiple uses and which may be more effective and less expensive than products of extensive, commercialized, and centrally controlled manufacture and distribution systems.

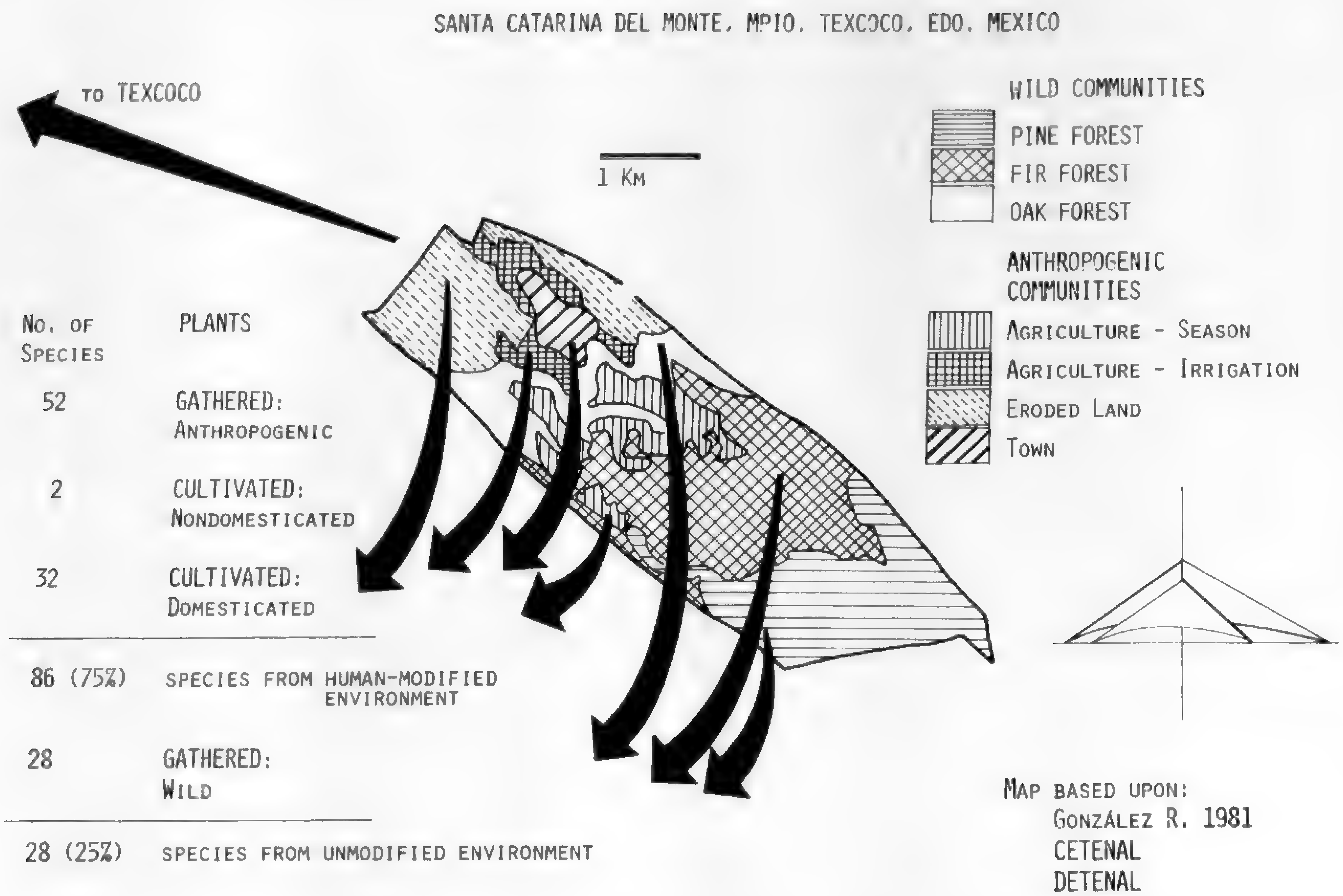


FIG. 7.–Map of the ejido of Santa Catarina del Monte, México, one of the source areas for medicinal herbs in Mercado de Sonora, Mexico City. The seven ecological zones are divided into 3 wild communities and 4 anthropogenic communities. An ecological analysis of the 114 species of medicinal plants of Santa Catarina del Monte is presented on the left.

LITERATURE CITED

BENITEZ, F. 1962. Los Primeros Mexicanos. La Vida Criolla en el Siglo XVI. Editorial ERA, S.A., México, DF.

BYE, R.A., JR. 1979. An 1878 ethnobotanical collection from San Luis Potosí: Dr. Edward Palmer's first major Mexican collection. Econ. Botany, 33(2):135-162.

CORTES, H. 1981. Carta de Relación, embiada a Su Sacra Magestad del Emperador nuestro señor por el Capitan General de la N. Espana. *In* Hernán Cortés, Historia de Nueva España. Tomo II. Miguel Angel Porrúa, S.A., and Secretariá de Hacienda y Crédito Público, México, DF.

DIAZ DE CASTILLO, B. 1977. Historia Verdadera de la Conquista de la Nueva España. Manuel Porrúa, S.A., México, DF.

GARIBAY K., A.M. 1961. Vida Económica de Tenochtitlan. (Informantes de Sahagún). Seminario de Cultura Náhuatl. Instituto de Historia, Univ. Nac. Autón. Méx., México, DF.

GONZÁLEZ, R. J. 1981. Ecologiá Humana y Etnobotanica de un Pueblo Campesino de la Sierra Nevada, México: Santa Catarina del Monte. Tesis de Biologiá, Univ. Nac. Auton. Méx., México, DF.

GUZMAN, G. 1981. Identificación de los Hongos Comestibles, Venenosos, Alucinantes, y Destructores de la Madera. Editorial Limusa, S.A., México, DF.

LEE, W.L., B.M. BELL, and J.F. SUTTON (eds.). 1982. Guidelines for Acquisition and Management of Biological Specimens. Assoc. Syst. Collections, Lawrence, Kansas.

PETERSON, F. 1959. Ancient Mexico—An introduction to the pre-Hispanic cultures. G.P. Putnam's Sons, New York.

RAMIREZ VAZQUEZ, P., et al. 1968. El Museo Nacional de Antropologiá: arte, arquitectura, arqueologiá, etnografiá. Panorama Editorial, Mexico, DF.

ROSE, J.N. 1899. Notes on useful plants of México. Contr. U.S. Natl. Herb. 5(4):209-259.

RYESKY, D., and M. PANIAGUA. 1979. El comercio en plantas medicinales en el sureste del Distrito Federal: cinco estudios de caso. Cuadernos de Trabajo 23, Depto. Etnol. Antrop. Soc., Inst. Nac. Antrop. Hist., México, DF.

RZEDOWSKI, J. 1964. Una especie nueva de pino piñonero del estado de Zacatecas (México). Ciencias (Méx.) 23(1):17-20, lam. II.

RZEDOWSKI, J. 1978. Vegetación de México. Editorial Limusa, S.A., Mexico, DF.

SAFFORD, W.E. 1918. *Chenopodium nuttalliae*, a food plant of the Aztecs. J. Wash. Acad. Sci. 8:521-527.

SAHAGUN, B. 1979. Códice Florentino. El manuscrito 218-20 de la Colección Palatina de la Bibilioteca Medicea Laurenziana. Archivo General de la Nación, México, DF.

TARACENA, B. 1981. Diego Rivera: Su obra mural en la Ciudad de México. Ediciones Galeria de Arte Misrachi, México, DF.

VALENCIA, E. 1965. La Merced. Estudio Ecológico y Social de una Zona de la Ciudad de Mexico. Serie Inviestigaciones 11. Inst. Nac. Antrop. Hist., México, DF.

WHITAKER, T.W., and H.C. CUTLER. 1966. Food plants in a Mexican market. Econ. Botany, 20(1):6-16.

ACKNOWLEDGEMENTS

This study is part of a project for developing an ethnobotanical data bank for a national germplasm conservation program, Unidad de Investigación sobre Recursos Genéticos Vegetales, of the Jardín Botánico, Instituto de Biologiá, Universidad Nacional Autónoma de México. We acknowledge the support of the Jardín Botánico (director, Hermilo Quero) and of the Instituto de Biologiá (director, José Sarukhán). Juan Manuel Pérez C. assisted in the preparation of the map. We thank the many friendly herb collectors and vendors for their patience, information, and hospitality in the markets and in their homes.

NOTES

1. Over 90 edible fungi have been recorded as being sold in Mexican markets (Guzman 1980:28-30).

Book Review

The Coronado Project Archaeological Investigations. The Specialist's Volume: Biocultural Analyses. compiled by Robert E. Gasser. 278 pp. Coronado Series 4, MNA Research Paper 23. Museum of Northern Arizona Press, Flagstaff, 1982. $12.50.

Analyses of prehistoric pollen, and plant and animal remains have become part of the "new ecological orthodoxy" central to many large archaeological projects in the last two decades. All too often these anlyses are based on very few samples and their results are relegated to the obscurity of appendices of various site reports. If their results are incorporated into the interpretation of site history and function it is usually as a passing note such as, "The occupants of this site grew corn, gathered wild plants, and hunted game." Hopefully this will not be the fate of the excellent work by Robert Gasser, Jannifer Gish, Richard Hevly, and Nicholas Czaplewski as they have provided extensive and detailed clues to understanding forty-seven sites located in railroad and transmission line right-of-ways associated with the Coronado Generating Station at St. John's, Arizona. It is now up to the archaeologists to fully utilize these results.

Gasser presents data from 339 flotation samples (272 of these produced plant remains) which, when combined with an additional 78 samples analyzed by Hevly, produces probably the largest published flotation data base available anywhere. Gasser also includes published and unpublished data from another 334 flotation samples from five other archaeological projects in the Anasazi area. Gasser has presented a creative solution to the problem of "what was eaten and in what proportions" in his comparison of 155 Anasazi coprolites and 417 Anasazi flotation samples. Future applications of this approach will help answer many of the unresolved questions in archaeobotany. With a data base of such magnitude one can truly address the problems of preservation, under-representation, and relative importance of various plant resources.

Gish analyzed 317 pollen samples. Major strengths of her approach are a concentration on pollen aggregates as a potential source of economic information and the integration of results from both pollen and flotation. All too often these two techniques are treated as being unrelated, but Gish has demonstrated that their results can complement each other quite nicely, providing both independent corroboration and also filling in many gaps.

Czaplewski's analysis of (both avian and mammalian) remains confirms what is becoming a now common conclusion in studies of bones from the sites of sedentary agriculturalists, that significant amounts of animal protein came from rodents and lagomorphs. Deer and antelope may have been occasional luxury foods, but small game was a protein staple. Agriculture is a subsistence adaptation that involves not only domesticated plants, but which also produces beneficial increases in useful weeds and "weedy" animals.

CHM

J. Ethnobiol. 3(1):15-38 May 1983

CHANGING SUBSISTENCE PRIORITIES AND EARLY SETTLEMENT PATTERNS ON THE NORTH COAST OF PERU

SHELIA POZORSKI
University of Pittsburgh, Center for Latin American Studies
Pittsburgh, PA 15260

ABSTRACT.—Two Cotton Preceramic sites and two early ceramic sites provide evidence of two major subsistence shifts which occurred between 2500 and 400 B.C. in the Moche Valley on the north coast of Peru. Plant and especially animal remains from the early preceramic site of Padre Aban suggest that the site was transitional in the change from a hunting and gathering to a marine-oriented sedentary lifestyle. Data from the late preceramic site of Alto Salaverry, which had a marine focus, made possible a reconstruction of subsistence activities at a point in time when agricultural technology was highly developed, but large areas of land were not yet opened through irrigation. In early ceramic times, the advent of irrigation agriculture is suggested by the inland location of Caballo Muerto and a greatly increased quantity of plant remains at Gramalote, an early coastal site. Faunal remains from the two sites provide evidence of an exchange system between Gramalote on the coast and Caballo Muerto, whereas a change in subsistence priorities is also documented by the large quantity of inland-derived animal resources used at Caballo Muerto.

INTRODUCTION

The transition to a settled way of life and the advent of irrigation agriculture are important steps which led to the emergence of civilization in the Andean area. Both of these changes can be closely correlated with shifts in subsistence orientation through time. The subsistence data from two Cotton Preceramic (2500-1800 B.C.) and two early ceramic (1800-400 B.C.) sites in the Moche Valley document details of early lifestyles and suggest possible explanations for two of the major changes.

METHODS

Excavations.—Excavations at the Cotton Preceramic sites of Padre Aban and Alto Salaverry and the early ceramic sites of Gramalote and Caballo Muerto yielded subsistence data upon which this study is based. Padre Aban and Alto Salaverry, both coastal sites, are the only Cotton Preceramic sites known within the Moche Valley. Caballo Muerto is a group of early ceramic mounds located about 17 km inland which date sequentially from about 1500 to 400 B.C. (T. Pozorski 1976:281). Gramalote, a coastal site, is contemporary with the earliest occupation of the Caballo Muerto mound group.

At all sites except Caballo Muerto, excavations consisted of small cuts varying in size from 50 cm by 100 cm to 100 cm by 200 cm placed in the stratified midden deposits that constituted all or major portions of each site. Extensive testing was carried out before a location was selected for excavation by natural levels and screening. Each selected cut was excavated by the removal of natural strata which were subdivided where necessary into 10 cm thick arbitrary levels. All midden material removed was dry-screened through ¼ inch mesh. In the case of Caballo Muerto, two pits sunk deeply into the Huaca Herederos Chica mound encountered sufficient midden material to provide a basis for quantitative analysis. Since these pits were only exploratory in nature, they were trowelled down by arbitrary 20 cm levels, but not dry screened.

Subsistence Analysis.—Due to its extreme aridity which favors preservation of faunal and floral remains to an extraordinary degree, the desert coast of Peru is one of the best places in the world for the study of prehistoric subsistence patterns. Nevertheless, coastal Peru, like other areas of the world, is subject to numerous predepositional and post-depositional factors which can affect the assemblage of material finally recovered by the archaeologist (Begler and Keatinge 1979; Cohen 1975). The value of any quantitative analysis lies not in the exact figures derived but rather in evidence of the *relative* importance of items within a cultural system.

For the present Moche Valley study, preservation factors at Padre Aban, Gramalote and Alto Salaverry are comparable because of the coastal location of these sites and the dryness of their respective middens. At Caballo Muerto, no floral material was preserved because the recovered midden was located several meters below the modern surface of agricultural land, a zone which has been subjected to periodic wetness for over 2,000 years. Since none of the controlled stratigraphic excavations showed any diachronic change in the artifact assemblage, all of the subsistence remains from any single cut are treated here as a single synchronic unit and assumed to be representative of the midden present at that site.

The following methodology was used in the study of early subsistence remains from the Moche Valley. All floral and faunal remains from each cut were identified as thoroughly as possible using modern comparative collections gathered in Peru which were positively identified by appropriate specialists. Counts were made of all meaningful portions of species present. For floral remains, seeds, stems, and cobs were counted. For faunal remains, an assessment of identifiable unduplicated parts made possible a reconstruction of the minimum number of animals of each species represented by a given faunal sample. For mollusks, whole valves and unbroken hinge regions were counted whereas gastropods were quantified by counting whole shells and shell apexes. The purple crab *(Platyanthus orbignii)* was counted by considering the presence of four claw arcs (2 claw arcs equal 1 whole claw) as one whole animal. For vertebrate animals, all diagnostic bones were counted. All floral and faunal remains were also weighed, a procedure which served not only as a check against minimum number of individual counts, but also to represent portions of the sample for which no diagnostic elements were present to make minimum number of individual counts. These minimum number of individual values and weights are available elsewhere (S. Pozorski 1976, Tables 5-13), but are not duplicated here because they were not used to calculate food volume.

Meaningful analytical units of conversion to food volumes were calculated using a modified version of the procedures established by MacNeish (1967:296-297) for Tehuacan. Conversion equivalents were established for most species using data on live weight or through experimentation. Most values for mammals came from the Tehuacan study (MacNeish 1967:296); and from White (1953:397-398) as well as Cardoza (1954:64) and Kostritsky (1963:35-36). Values for fish, shellfish and most plants were determined experimentally. These values or volumes are presented in Tables 1 and 2.

TABLE 1.–*Animal food species conversion factors.*

Species	Total meat volume in cm^3	Number of diagnostic elements	Meat unit in cm^3
MOLLUSKS			
Scutalus sp. (land snail)	2.0	1	2.0
Choromytilus chorus (purple mussel, *choro)*	50.0	2	25.0
Semimytilus algosus (thin-shelled mussel)	1.0	2	0.5
Brachidontes purpuratus (small striated mussel)	1.0	2	0.5

TABLE 1.–*Animal food species conversion factors* (continued)

Species	Total meat volume in cm^3	Number of diagnostic elements	Meat unit in cm^3
Protothaca thaca (large clam)	20.0	2	10.0
Eurhomalea rufa (large clam)	40.0	2	20.0
Mesodesma donacium (clam)	5.0	2	2.5
Donax peruvianus (tide zone clam)	0.5	2	0.25
Gariet solida (large clam)	20.0	2	10.0
Semele corrugata (large clam)	60.0	2	30.0
Fissurella sp. (limpet)	10.0	1	10.0
Tegula atra (gastropod)	1.0	1	1.0
Turbo niger (gastropod)	1.0	1	1.0
Crepidula dilatata (slipper shell)	1.25	1	1.25
Polinices sp. (gastropod)	0.5	1	0.5
Thais chocolata (gastropod)	2.0	1	2.0
Thais delessertiana (gastropod)	1.5	1	1.5
Concholepas concholepas (abalone-like gastropod)	50.0	1	50.0
Chiton	10.0	8	1.25
CRUSTACEANS			
Platyanthus orbignii (purple crab, congrejo)	20.0	4 claws	5.0
ASCIDIAN			
Pyura chilensis (?) (tunicate, *pieure)*	meal vol. per gm of test		1.0
FISH			
Mustelus sp. (sand shark, *tollo)*	2,000.0	90	22.0
Rhinobatos planiceps (guitarfish, *guitarra)*	1,500.0	120	12.5
Myliobatis peruvianus (ray, *raya)*	2,000.0	56	35.5
Paralonchurus peruanus (croaker, *roncador)*	750.0	48	15.5
Sciaena gilberti (croaker, *corvina)*	3,000.0	27	111.0

TABLE 1.–*Animal food species conversion factors* (continued)

Species	Total meat volume in cm^3	Number of diagnostic elements	Meat unit in cm^3
Sciaena deliciosa (croaker, *lorna)*	750.0	46	16.5
Xenoscarus denticulatus (parrot fish, *pococho)*	500.0	25	20.0
Sarda chilensis (bonito)	1,500.0	42	35.5
Lepisoma philippi *(trambollo)*	750.0	25	30.0
Genypterus maculatus (eel, *congrio)*	1,000.0	46	21.5
Mugil cephalus (mullet, *lisa)*	750.0	23	32.5
Unidentified fish	meat vol. per gm of bone		25.0
BIRDS			
Pelecanus sp. (pelican)	3,000.0	47	64.0
Unidentified bird	meat vol. per gm of bone		14.0
MAMMALS			
Otaria byronia (sea lion, *lobo del mar)*	100,000.0	138	724.5
Lama glama (llama)	50,000.0	120	416.5
Odocoileus virginianus (deer, *venado)*	50,000.0	120	416.5
Unidentified mammal	meat vol. per gm of bone		42.5
Unidentified sea mammal	meat vol. per gm of bone		35.5

In determining food volume for individual plant remains, such as seeds, conversion is quite straightforward, dependent only on the number of seeds per fruit. For example, one whole avocado seed equals one fruit which is equal to 125 cm^3 of food. For bivalve mollusks, conversion to meat volumes is a simple procedure. For example, an average *Choromytilus chorus* mussel yields 50 cm^3 of meat. Since it has two valves, each valve or hinge would represent 25 cm^3 of meat.

Conversion equivalents for vertebrates are slightly more complicated. The total meat volume of a given animal is divided by the number of its diagnostic skeletal elements to yield an average meat volume per diagnostic skeletal element value. For example, the croaker *Paralonchurus peruanus* has an average meat volume of 750 cm^3 and 48 diagnostic elements (including total vertebrae and head bones) in its skeleton which yields a meat volume per diagnostic skeletal element value of about 15.5 cm^3. If 10 diagnostic elements of *P. peruanus* are found in a cut, then 155 cm^3 of meat are represented. Though it is likely that some diagnostic elements of a skeleton represent more meat volume than others (such as mammal long bones versus mammal head bones), no studies have yet been made to determine these differences. Consequently each diagnostic element is treated equally. In contrast to simple minimum number of individual counts which overrepresent rare species, the methodological procedure described here bases food volume quantifications on only the parts of each animal which are actually recovered archaeologically.

TABLE 2.—*Plant food species conversion factors.*

Species	Units per liter	Unit Equivalent	Food unit in cm^3
Arachis hypogaea (peanut, *maní*)	2000 seeds	0.5 shell	0.5
Phaseolus lunatus (lima bean, *pallar*)	750 seeds	1 seed	1.33
Phaseolus vulgaris (common bean, *fri jol*)	2500 seeds	1 seed 0.2 pod	0.4
Capsicum sp. (pepper, *a jí*)	50 fruit	1 stem	20.0
Cucurbita sp. (squash, *calabaza*)	1 fruit	1 stem 50 seeds	1000.0
Persea americana (avocado, *palta*)	8 fruit	1 seed	125.0
Inga feuillei (*pacae*)	10 beans	20 seeds	5.0
Bunchosia armeniaca (*cansaboca*)	50 fruit	2 seeds	20.0
Psidium guajava (guava, *guayaba*)	30 fruit	1 fruit	33.0
Lucuma obovata (*lúcuma*)	8 fruit	1 seed	125.0

DISCUSSION

Padre Aban.—Padre Aban, located near the modern fishing village of Huanchaco and about 200 m from the ocean (Fig. 1), is a tiny site which covers only about 100 sq m. No architecture is present and the only cultural component is stratified midden which reaches a depth of 140 cm. Selected by prior testing, one controlled stratigraphic excavation 100 cm x 100 cm x 140 cm deep yielded the subsistence data for this study. Cotton cord and net fragments were recovered, but no textiles were found, and Moseley (1975: 22) has argued for the placement of such sites very early in the Cotton Preceramic. Subsistence data indicate that the site was transitional in the change from hunting and gathering to sedentary life, a feature which would also tend to place it quite early. Four carbon-14 samples from three levels with abundant plant remains submitted to the Radiocarbon Laboratory of the University of Texas at Austin yielded the following dates: 1720+260 B.C. (sample Tx-1935), 1900+210 B.C. (sample Tx-1933), 1980+120 B.C. (sample Tx-1934) and 3470+140 B.C. (sample Tx-1936) (S. Pozorski 1976:19). Although the earliest date was based on a small sample and is probably atypical, the other dates cluster more closely and generally date the beginnings of sedentary life within the Moche Valley.

Padre Aban is transitional in the process toward sedentism, during a time when local inland hunting and gathering activities were being phased out. This may be correlated with the stabilization of marine resources after the attainment of modern sea level about 3000 B.C. (Richardson 1981). The small size and absence of architecture suggest semipermanence and seasonal use, and concurrently these very characteristics substantiate the inference that food procurement was the local activity of paramount importance. At Padre Aban, which was economically intermediate between hunting and gathering and systematic marine collecting supplemented by floodplain agriculture, there is evidence of 1) remnants of familiar traditional procurement systems such as hunting and 2) incomplete adaptation to the new environment being exploited.

Since the immediate vicinity of Padre Aban is too barren to support much animal or plant life, the site inhabitants probably depended on the ocean for the animal protein which constituted the bulk of their diet (S. Pozorski 1976:71-76). Shellfish, mainly

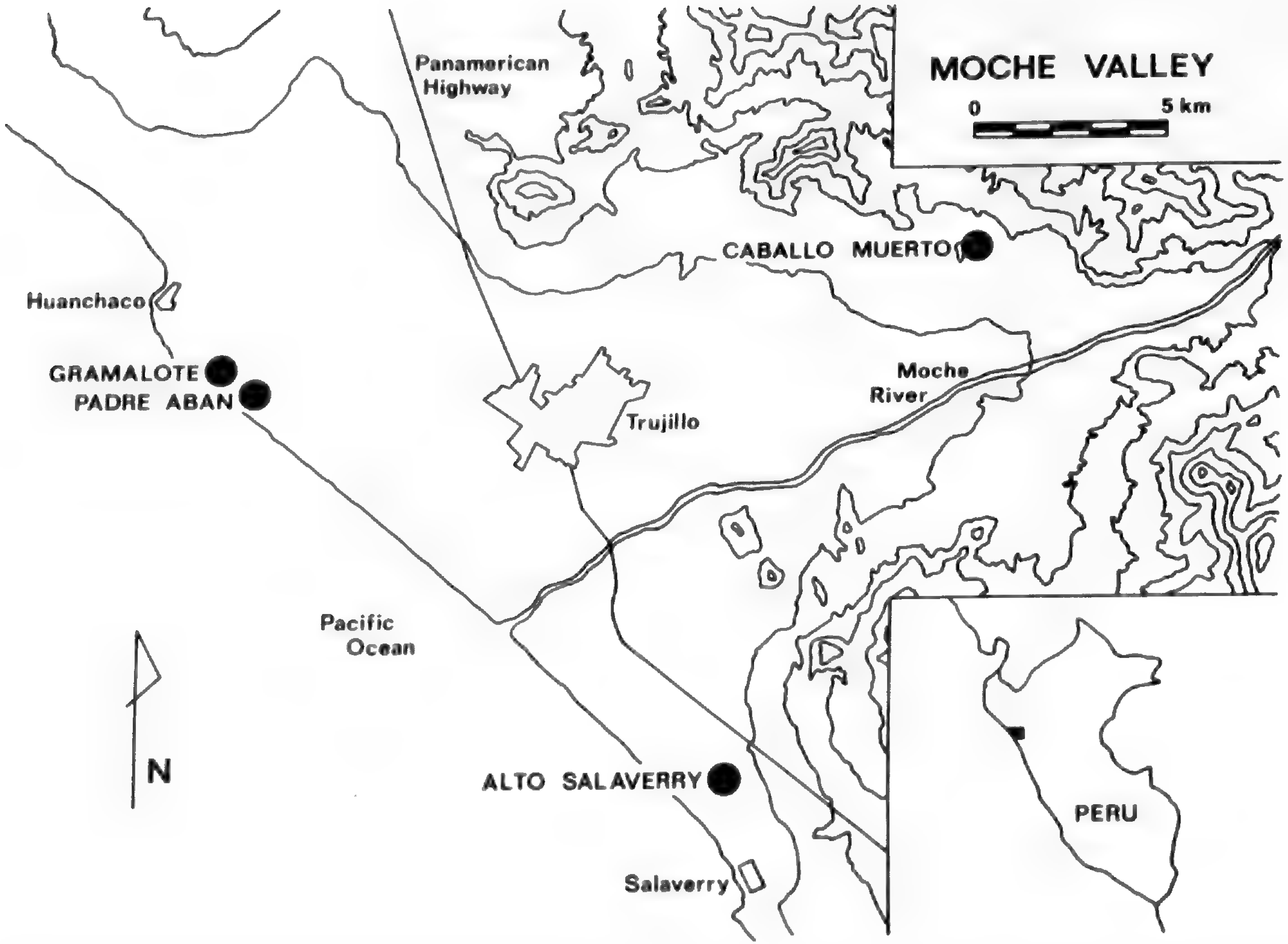


FIG. 1.–Map of the Moche Valley showing the location of the Cotton Preceramic sites of Padre Aban and Alto Salaverry and the early ceramic sites of Gramalote and Caballo Muerto.

TABLE 3.—*Cotton Preceramic Animal Remains*

	Padre Aban			Alto Salavery					
				Cut 1			Cut 2		
Species	Diagnostic elmts.	Meat vol. in cm3	% of meat diet	Diagnostic elmts.	Meat vol. in cm3	% of meat diet	Diagnostic elmts	Meat vol. in cm3	% of meat diet
MOLLUSKS									
Scutalus sp. (land snail)	0	+	+	2	4.0	+	1	2.0	+
Choromytilus chorus (purple mussel, *choro*)	513	12825.0	31.5	108	2700.0	17.9	162	4050.0	18.2
Semimytilus algosus (thin-shelled mussel)	1022	511.0	1.2	2239	1119.5	7.4	2186	1093.0	4.9
Brachidontes purpuratus (small striated mussel)	1	0.5	+	463	231.5	1.5	680	340.0	1.5
Protothaca thaca large clam	94	940.0	2.3	1	10.0	0.1	0	+	+
Eurhomalea rufa (large clam)	46	920.0	2.2	0	0	0	0	+	+
Mesodesma donacium (clam)	15	37.5	0.1	12	30.0	0.2	9	22.5	0.1
Donax peruvianus (tide zone clam)	3503	875.8	2.2	788	197.0	1.3	576	144.0	0.6
Semele corrugata (large clam)	3	90.0	0.2	0	0	0	0	0	0
Fissurella sp. (limpet)	0	+	+	30	300.0	2.0	40	400.0	1.8
Tegula atra (gastropod)	77	77.0	0.2	58	58.0	0.4	27	27.0	0.1
Turbo niger (gastropod)	68	68.0	0.2	71	71.0	0.5	38	38.0	0.2

TABLE 3.–*Cotton Preceramic Animal Remains (continued)*

	Padre Aban			Alto Salaverry					
				Cut 1			Cut 2		
Species	Diagnos-tic elmts.	Meat vol. in cm3	% of meat diet	Diagnos-tic elmts	Meat vol. in cm3	% of meat diet	Diagnos-tic elmts.	Meat vol. in cm3	% of meat diet
MOLLUSKS (continued)									
Crepidula dilatata (slipper shell)	36	45.0	0.1	12	20.0	0.1	31	38.8	0.2
Thais chocolata (gastropod)	13	26.0	0.1	10	20.0	0.1	5	10.0	+
Thais delessertiana (gastropod)	30	45.0	0.1	27	40.5	0.3	14	21.0	0.1
Concholepas concholepas (abalone-like gastropod)	0	0	0	2	100.0	0.7	4	200.0	0.9
Chiton	3	3.8	+	14	17.5	0.1	14	17.5	0.1
Rare molluscan species		+	+		+	+		+	+
CRUSTACEAN									
Platyanthus orbignii (purple crab, *congrejo)*	107	535.0	1.3	205	1025.0	6.8	300	1500.0	6.7
ASCIDIAN									
Pyura chilensis (?) (tunicate, *pieure)*	6886.5g	6886.5	16.9	0	0	0	0	0	0
FISH									
Mustelus sp. (shark, *tollo)*	105	2310.0	5.7	32	704.0	4.7	36	792.0	3.6
Rhinobatos planiceps (guitarfish, *guitarra)*	0	0	0	18	225.0	1.5	0	0	0

TABLE 3.—*Cotton Preceramic Animals Remains (continued)*

Species	Padre Aban			Alto Salaverry Cut 1			Alto Salaverry Cut 2		
	Diagnostic elmts.	Meat vol. in cm3	% of meat diet	Diagnostic elmts.	Meat vol. in cm3	% of meat diet	Diagnostic elmts.	Meat vol. in cm3	% of meat diet
FISH (continued)									
Myliobatis peruvianus (ray, *raya*)	11	390.5	1.0	7	248.5	1.6	20	710.0	3.2
Paralonchurus peruanus (croaker, *roncador*)	10	155.0	0.4	47	728.5	4.8	48	744.0	3.3
Sciaena gilberti (croaker, *corvina*)	1	111.0	0.3	0	0	0	0	0	0
Sciaena deliciosa (croaker, *lorna*)	30	495.0	1.2	216	3564.0	23.6	186	3069.0	13.8
Xenoscarus denticulatus (parrot fish, *pococho*)	0	0	0	0	0	0	6	120.0	0.5
Sarda chilensis (bonito)	0	0	0	3	106.5	0.7	2	71.0	0.3
Lepisoma philippi (*trambollo*)	3.5	105.0	0.2	3	90.0	0.6	11.5	345.0	1.5
Genypterus maculatus (eel, *congrio*)	0	0	0	0	0	0	2	43.0	0.2
Mugil cephalus (mullet, *lisa*)	38	1235.0	3.0	3	97.5	0.6	60	1950.0	8.7
Unidentified fish	180g	4500.0	11.1	90g	2250.0	14.9	135g	3375.0	15.1
BIRDS									
Pelecanus sp. (pelican)	8	512.0	1.2	0	0	0	0	0	0
Unidentified bird	447.5g	6265.0	15.4	2.5g	35.0	0.2	12.5g	175.0	0.8

TABLE 3.–*Cotton Preceramic Animals Remains (continued)*

Species	Padre Aban			Alto Salaverry Cut 1			Alto Salaverry Cut 2		
	Diagnostic elmts.	Meat vol. in cm3	% of meat diet	Diagnostic elmts.	Meat vol. in cm3	% of meat diet	Diagnostic elmts.	Meat vol. in cm3	% of meat diet
MAMMALS									
Otaria byronia (sea lion, *lobo del mar)*	1	724.5	1.8	1.5	1086.8	7.2	4	2898.0	13.0
Unidentified sea mammal	0	0	0		+	+	2.5g	88.8	0.4
Total		40689.1	99.9		15079.8	99.8		22284.6	99.8
Combined + values			0.1			0.2			0.2
(+ = less than 0.1%)			100.0%			100.0%			100.0%

mollusks, comprised more than half the total animal protein represented in the archaeological collection (Table 3), and the species inventory reflects access to both rock and sand littoral habitats which are juxtaposed in the vicinity of Padre Aban.

The strong dietary emphasis on mollusks at Padre Aban suggests systematic procurement methods. However, a comparison of the shellfish inventory of the site with the later marine-oriented settlement of Gramalote nearby reveals that collecting by the people from Padre Aban was relatively ineffective—perhaps because marine species and habitats were unfamiliar. The old adage "What you see is what you get" could well be applied to the inhabitants of Padre Aban because the mollusks most frequently taken were species which were most visible and accessible. Mussels *(Choromytilus chorus* and *Semimytilus algosus)* and other rock-perching species *(Thais chocolata, Thais delessertiana, Tegula atra, Turbo niger,* and *Crepidula dilatata)* can be collected on rocks at low tide. The small coquina clam *(Donax peruvianus)* inhabits the active tide zone where it is frequently washed out by waves and easily collected with the bare hand (Fitch 1953: 84-85; Carson 1955:137). However, the larger clams *(Eurhomalea rufa, Protothaca thaca,* and *Semele corrugata)* which yield more meat per animal, lie buried more deeply, often in gravel under rocks (Fitch 1953:65-66, 68, 83; Olsson 1961:305-306; Keen 1971: 193, 250-255). The extreme abundance of these larger species at the later nearby site of Gramalote from which they were systematically exploited suggests that even their most frequent occurrences at Padre Aban represent fortuitous finds rather than conscious exploitation of harder-to-reach habitats.

As shells from Padre Aban were identified and studied, several significant patterns emerged. First, shells from the large purple mussel *(C. Chorus)* were quite large (Table 7) and heavily riddled by shell parasites in the posterior region, whereas very few juvenile individuals were recorded. This suggests that local mussel colonies were certainly not yet being exploited systematically enough or in such quantities that normal growth and maturation were impaired. It is possible that colonies collected by people from Padre Aban were being taken regularly for the first time—thus accounting for the large numbers of very large and old individuals. Unnatural, but consistent, fractures producing patterned breaks at right angles were noted near the hinges of bivalves, and chunks of whorl sections had been chopped away to facilitate access to retracted gastropods. Such shell cracking could have been performed easily using a beach cobble. Dead or cooked shellfish are easily opened; therefore the species taken near Padre Aban were probably cracked and eaten while still raw. A number of whole or nearly whole large mussel valves were extremely worn along the posterior margin from use as scrapers.

In addition to mollusk shells, large numbers of tunicate (probably *Pyura chilensis)* tests (leathery outer coverings) were recovered from the midden. Their soft internal parts were eaten much as sea urchins are consumed.

Fish taken near the site provided about 27% of the total reconstructed animal protein (Table 3). Shark *(mustelus* sp.), ray *(Myliobatis peruvianus),* mullet *(Mugil cephalus)* and a single species of croaker *(Sciaena deliciosa)* are most common, and all of these species frequent shallow water near shore where they are easily surrounded and dragged ashore using a simple haul seine (Evermann and Radcliffe 1917; Hildebrand 1946). Tiny fragments of small-mesh (4-5 mm) cotton netting recovered during excavation provide evidence for this mode of procurement.

Shore birds figure prominently in the faunal inventory. Pelicans, cormorants, and gull-sized species account for about 20% of the total meat represented by the faunal sample (Table 3). This unusually high frequency of bird consumption far exceeds that of any other Moche Valley site studied and may reflect a continuation of the familiar hunting activities practiced by earlier nonsedentary groups. Shore birds represent the only large class of coastal animals which the people of Padre Aban could deal with in a traditional manner. The only mammal recognized as a potential food animal is the sea lion *(Otario byronia),* and since the remains are few (Table 3), they probably represent fortuitous finds.

The beginnings of plant cultigen use occurred concurrently with early efforts toward systematic marine resource use by Padre Aban's small population (S. Pozorski 1976: 76-78). Only three cultivated species: squash *(Cucurbita* sp.), gourd, *(Lagenaria siceraria),* and cotton *(Gossypium barbadense)* were recovered from the Padre Aban midden (Table 4). These plants were probably cultivated in seasonally inundated plots on the Moche River floodplain, as cultivation would have been impossible in the arid vicinity of the site.

The cultivated plant inventory of Padre Aban reflects an emphasis on industrial plants, with their food potential secondary in importance. Although immature gourds may have been eaten, cotton and gourds were most important to the people of Padre Aban as a source of raw materials. Squash may have been used as containers as well as for food (Pickersgill and Smith 1981:99).

Alto Salaverry.–The Cotton Preceramic site of Alto Salaverry lies approximately 1.65 km from the ocean at an elevation of about 120 m on a ridge overlooking the ocean (Fig. 1). Both midden and architecture are present, forming an oval about 160 m N-S by 120 m E-W in an area of stabilized dunes. The architecture, of well built wet-laid adobe, cobble, and boulder construction, was both domestic and nondomestic in function (S. Pozorski and T. Pozorski 1977; 1979a). Extensive testing revealed that midden is deepest in areas between units of domestic architecture where it reaches a depth of 155 cm, and two loci within this concentration were selected for controlled excavation. Cut 1 measured 100 cm x 200 cm x 115 cm deep and cut 2 measured 100 cm x 175 cm x 150 cm deep. Although no absolute dates are available, three features of Alto Salaverry argue for its placement later than Padre Aban and near the end of the Cotton Preceramic: (1) twined textiles are abundant; (2) plant cultigens are varied and occasionally frequently represented; and (3) features of the nondomestic architecture resemble early ceramic units in the Moche Valley and other central and north coast valleys (S. Pozorski 1976: 20-21, 79-91; T. Pozorski 1976; S. Pozorski and T. Pozorski 1977, 1979a).

Alto Salaverry represents the final step in the preceramic process of adaptation. Excavation data reveal a complex permanent settlement featuring functionally differentiated architecture indicative of simple societal ranking. Food procurement and processing were no longer the only important site activities. Marine products figure prominently in the site economy, yet plant cultigens, especially industrial plants, were of considerable importance (S. Pozorski 1976:79-91).

Shellfish comprised about 38% of the reconstructed animal protein, and prominent species in the midden include mussels, gastropods, limpets, and chitons. All are types which require the rocky littoral habitat locally available at Salaverry point (Olsson 1961; Keen 1971). Clearly, the inhabitants of Alto Salaverry exploited the more distant, but richer, biomass of the rocky point instead of the sand beach only half as distant. The large clams taken by the people of Padre Aban and the later site of Gramalote from the rock-strewn coastline and sheltered waters of Huanchaco Bay were apparently absent from the sandy open beach near Alto Salaverry.

Compared to the large mussel *(C. chorus)* shells from Padre Aban, most of the mussel shells from Alto Salaverry were smaller, younger and generally unmarked by parasites (Table 7). This evidence suggests that shellfish collecting by people based at Alto Salaverry put much more pressure on mussel, and possibly other local mollusk, populations than did collecting by people from Padre Aban. Extremely large numbers of shellfish, including *C. chorus,* were taken in the Huanchaco area into early ceramic times, suggesting that populations of shellfish there were relatively larger and perhaps more stable.

Larger shells, especially the purple mussel, exhibit a consistent fracture pattern for meat extraction comparable to the pattern observed in Padre Aban material. Other examples show evidence of use as crude scrapers.

Fish supplied over half of the total animal protein consumed at Alto Salaverry (Table 3), and remains of fishing gear are prominent among the artifacts. Major species closely parallel those taken at Padre Aban. Sharks, rays, guitarfish, mullet, and, to some extent, croakers are easily trapped with haul seines as they feed near shore, whereas bony fishes, mainly croakers, may have been caught off the Salaverry rock mass as they came in to feed off sedentary animal life on the rocky outcrop.

TABLE 4.—*Cotton Preceramic Food Plant Remains*

Species	Padre Aban			Alto Salaverry Cut 1			Alto Salaverry Cut 2		
	Diagnostic elmts.	Food vol. in cm3	% of plant diet	Diagnostic elmts.	Food vol. in cm3	% of plant diet	Diagnostic elmts.	Food vol. in cm3	% of plant diet
Phaseolus lunatus (lima bean, *pallar)*	0	0	0	5.5	7.3	0.1	4	5.3	0.1
Phaseolus vulgaris (common bean, *fri jol)*	0	0	0	2.5	1.0	+	2	0.8	+
Capsicum sp. (pepper, *a jí)*	0	0	0	1 stem	20.0	0.2	3 stems	60.0	1.1
Cucurbita sp. (squash, *calabaza)*	1 stem	1000.0	100.0	9 stems	9000.0	96.0	5 stems	5000.0	92.1
Persea americana (avocado, *palta)*	0	0	0	0.5	62.5	0.7	2	250.0	4.6
Inga feuillei *(pacae)*	0	0	0	0	0	0	0.5	2.5	+
Bunchosia armeniaca *(cansaboca)*	0	0	0	3	30.0	0.3	11	110.0	2.0
Psidium guajava (guava, *guayaba)*	0	0	0	2 stems	66.0	0.7	0	0	0
Lucuma obovata *(lũcuma)*	0	0	0	1.5	187.5	2.0	0	0	0
Total		1000.0	100.0%		9374.3	100.0%		5428.6	99.9
Combined + values									0.1
(+ = less than 0.1%)									100.0%

Shore birds were insignificant in the diet at Alto Salaverry—a marked contrast to their high frequency at Padre Aban. However, sea lions, which were rare at Padre Aban, contributed substantially to the meat protein consumed at Alto Salaverry. Although the contribution of these animals to the diet (about 7%) is small compared to shellfish and fish, it indicates that these animals were regularly killed in the vicinity of Salaverry point.

The three plant cultigens, cotton, gourd, and squash, documented for Padre Aban, are most abundant in the Alto Salaverry material (Table 4). Again, industrial plants are extremely important, indicating a prevailing attitude toward plant cultivation as a means for obtaining essential raw materials. However, food plant production was increasing in importance. Though well behind squash, *cansaboca (Bunchosia armeniaca), lúcuma (Lucuma obovata),* and avocado *(Persea americana)* contributed substantially to the vegetable diet. Cultivated beans were probably more common that their calculated frequency would indicate because the seed is the part that is eaten. Other cultivated or tended species identified include pepper *(Capsicum* sp.), *pacae (Inga feuillei),* and guava *(Psidium guajava).* All these species were probably brought from the valley bottom where floodplain cultivation was possible and where moisture was available for wild or tended plants.

Cotton Preceramic Subsistence.—A comparison of Padre Aban and Alto Salaverry reveals both similarities which point to characteristics applicable to the period as a whole and contrasting elements which are indicative of important changes within the period. A dependence on marine resources for virtually all animal protein is one of the most important features common to both sites. Discrepancies in the faunal inventories are largely explained by either differences in local technologies or the availability of particular species in the vicinity of each site. The overall increase in the proportion of fish at Alto Salaverry may reflect a change of focus with respect to procurement activities because shellfish had been overexploited and were smaller and harder to find and because additional fish species could be taken from the Salaverry rock mass. The high proportion of bird remains at Padre Aban is seen primarily as resulting from holdovers of the hunting technology characteristic of a group in the process of adapting to a marine focus. Discrepancies in the molluscan inventories of the two sites provide evidence of differences in the fauna inhabiting the coastal zones easily accessible from each site. Certain rock-perching species are common to both sites. However, the large clams *(S. corrugata, P. thaca,* and E. *rufa)* and tunicates were recovered in quantity only from Padre Aban and Gramalote near Huanchaco Bay. Similarly, one mussel species *(Brachidontes purpuratus), Concholepas concholepas,* chitons, and limpets are either restricted to or much more common in the Alto Salaverry refuse.

Cotton, gourd, and squash are the only plant cultigens common to both sites, representing the only cultivated species from Padre Aban and the dominant species in the Alto Salaverry inventory. Other food plants represented in the Alto Salaverry midden reflect an increased emphasis on plant cultivation coupled with tree fruit tending. It is significant that the main species at both preceramic sites are industrial plants: cotton and gourd. To people without pottery and with a marine focus, gourd containers and floats and cotton net and cord would have been extremely important—more important than plant food, since animal protein was so readily available. As a result, people viewed plant cultivation essentially as a means for obtaining necessary raw materials. Such a bias in favor of industrial plant cultivation could easily have resulted in the neglect and limited production of most food species. Another factor, the areal limits on floodplain land suitable for cultivation, may have ultimately been a key variable. The Alto Salaverry data indicate that with usable land in short supply and the resulting limited production concentrating on industrial plants, food plant production was small and secondary (S. Pozorski 1976:81-97).

Gramalote.—The early ceramic site of Gramalote occupies a series of bluffs about 70 m from the ocean near Huanchaco (Fig. 1). Midden and vestiges of architecture cover a total area of about 16,500 sq m. Much of the architecture is deeply buried by midden, but excavation exposed elaborate structures of wet-laid double-faced cobble and boulder walls with rubble fill (S. Pozorski and T. Pozorski 1979b). Stratified midden reaches a depth of almost 2 m, and a single cut in the deepest zone yielded subsistence data for this study. This cut measured 100 by 50 cm by 195 cm deep. Six carbon-14 samples from Gramalote processed by the Radiocarbon Laboratory of the University of Texas at Austin yielded dates which ranged from about 1590 to 1100 B.C. (S. Pozorski 1976:22; S. Pozorski and T. Pozorski 1979b).

In keeping with the pattern already observed for early maritime sites, all the animal protein consumed at Gramalote derived ultimately from the nearby ocean (Table 5). The procurement and processing of shellfish was the major subsistence activity at Gramalote, and virtually all the species identified at the site were also collected by the earlier inhabitants of the region at Padre Aban. Quantitative differences in the species taken by people from Gramalote compared to Padre Aban can be attributed to the more efficient

TABLE 5.—*Early Ceramic Animal Remains*

Species	Gramalote			Caballo Muerto		
	Diagnostic elmts.	Meat volume in cm3	% of meat diet	Diagnostic elmts.	Meat volume in cm3	% of meat diet
MOLLUSKS						
Scutalus sp. (land snail)	9	18.0	+	21	42.0	0.4
Choromytilus chorus (purple mussel, *choro)*	333	8325.0	7.2	83	2075.0	21.9
Semimytilus algosus (thin-shelled mussel)	616	308.0	0.3	13	6.5	0.1
Protothaca thaca (large clam)	1599	15990.0	13.7	46	460.0	4.9
Eurhomalea rufa (large clam)	183	3660.0	3.1	11	220.0	2.3
Donax peruvianus (tide zone clam)	212	53.0	+	63	15.8	0.2
Gariet solida (large clam)	171	1710.0	1.5	0	0	0
Semele corrugata (large clam)	1006	30180.0	26.0	81	2430.0	25.7
Fissurella sp. (limpet)	18	180.0	0.1	2	20.0	0.2
Tegula atra (gastropod)	1243	1243.0	1.1	16	16.0	0.2
Turbo niger (gastropod)	925	925.0	0.8	4	4.0	+
Crepidula dilatata (slipper shell)	65	81.3	0.1	2	2.5	+
Thais chocolata (gastropod)	96	192.0	0.2	0	0	0
Thais delessertiana (gastropod)	435	652.5	0.6	1	1.5	+
Chiton	11	137.5	0.1	0	+	+
Rare molluscan species		+	+		+	+

TABLE 5.–*Early Ceramic Animal Remains (continued)*

Species	Gramalote: Diag-nostic elmts.	Gramalote: Meat volume in cm3	Gramalote: % of meat diet	Caballo Muerto: Diag-nostic elmts.	Caballo Muerto: Meat volume in cm3	Caballo Muerto: % of meat diet
CRUSTACEAN						
Platyanthus orbignii (purple crab, *congrejo)*	1187	5935.0	5.1	20	100.0	1.0
ASCIDIAN						
Pyura chilensis (?) (tunicate, *pieure)*	1149g	1149.0	1.0	0	0	0
FISH						
Mustelus sp. (shark, *tollo)*	304	6688.0	5.7	0	0	0
Rhinobatos planiceps (guitarfish, *guitarra)*	57	712.5	0.6	0	0	0
Myliobatis peruvianus (ray, *raya)*	18	639.0	0.5	0	0	0
Paralonchurus peruanus (croaker, *roncador)*	25	387.5	0.3	0	0	0
Sciaena gilberti (croaker, *corvina)*	7	777.0	0.7	0	0	0
Sciaena deliciosa (croaker, *lorna)*	39	643.5	0.5	3	49.5	0.5
Unidentified fish	25g	625.0	0.5	0	0	0
BIRDS						
Pelecanus sp. (pelican)	3	192.0	0.2	0	0	0
Unidentified bird	505g	7070.0	6.1	2.5g	35.0	0.4
MAMMALS						
Otaria byronia (sea lion, *lobo del mar)*	12	8694.0	7.5	0	0	0
Lama glama (llama)	0	0	0	3.5	1457.8	15.4
Odocoileus virginianus (deer, *venado)*	0	0	0	4	1666.0	17.6
Unidentified mammal	0	0	0	20g	850.0	9.0
Unidentified sea mammal	537.5g	19081.3	16.4	0	0	0
Total		116249.1	99.9		9451.6	99.8
Combined + values			0.1			0.2
(+ = less than 0.1%)			100.0%			100.0%

procurement system in operation at Gramalote. Shellfish gathering by the people at Padre Aban focused on the more visible, easily gathered species, whereas shellfish gatherers from Gramalote collected the deeper burrowing clams *(P. thaca, E. rufa, S. corrugata,* and *Gariet solida)* which supply more meat per individual than all but the large mussel *(C. chorus),* as well as the more accessible species. Once a method was established for taking these large mollusks efficiently, procurement activities focused on shellfish collection (S. Pozorski 1976:93-97).

Like examples from Padre Aban, specimens of the large mussel from the Gramalote midden were usually large adult individuals, often affected by parasites (Table 7), thus there was no apparent depopulation of the Huanchaco Bay shellfish beds. The same shell breakage pattern observed for Padre Aban and Alto Salaverry was documented for Gramalote shellfish. Large bivalves and many gastropods had been bashed open in a consistent manner to extract the meat. Large clam and mussel valves had been used as scrapers.

In contrast to Padre Aban where almost 30% of the meat protein was fish-derived and especially Alto Salaverry where over 50% was from fish, at Gramalote less than 10% of the total meat protein was derived from fish (Table 5). Shark provided more meat than all other fish species combined, and rays, guitarfish, and three members of the croaker family were also represented. Fishing implements recovered during excavations indicate that fishing was probably done using both simple small-mesh haul seines and large-mesh gill nets staked out in shallow water.

Although not as common as remains from Padre Aban, bird bones from Gramalote indicate that several species were taken with some regularity. The only mammal of dietary significance was the sea lion, which was taken and consumed in a quantity comparable to that documented for Alto Salaverry (Table 5).

Cultivated plant species identified at Gramalote include the same plants identified for Alto Salaverry plus the newly introduced peanut *(Arachis hypogaea)* and maize *(Zea mays).* The industrial plants, cotton and gourd, as well as squash continued to be abundant, but other food species were present in substantial amounts (Table 6). *Lúcuma,* avocado, the common bean, and pepper had attained special importance in the vegetable diet, but maize was not yet an important food plant (S. Pozorski 1976:97-98).

TABLE 6.—*Early Ceramic Food Plant Remains*

	Gramalote		
Species	Diagnostic elements	Food volume in cm3	% of plant diet
Zea mays (maize, *maîz)*		+	+
Arachis hypogaea (peanut, *manî)*	195 shells	97.5	1.0
Phaseolus vulgaris (common bean, *frijol)*	40 pods	80.0	0.8
Capsicum sp. (pepper, *ajî)*	17 stems	340.0	3.6
Cucurbita sp. (squash, *calabaza)*	298 seeds	5960.0	63.5
Persea americana (avocado, *palta)*	5 seeds	625.0	6.7
Bunchosia armeniaca *(cansaboca)*	10 seeds	100.0	1.1
Lucuma obovata *(lucuma)*	17.5 seeds	2187.5	23.3
Total		9390.0	100.0%

TABLE 7.– *Ratio of MNI to Total Shell Weight for Choromytilus chorus*

Site	MNI	Wt. of Shell	MNI ÷ Shell Wt.
Padre Aban	257	7707.5	29.99
Alto Salaverry Cut 1	54	942.5	17.45
Alto Salaverry Cut 2	81	1860.0	22.96
Gramalote	167	4530.0	27.13

Caballo Muerto.–The Caballo Muerto complex is a group of eight early ceramic platform mounds located about 17 km inland on the north side of the valley (Fig. 1) and spread over an area of about 2 sq km. Intensive excavation by Thomas Pozorski revealed that each mound is a U-shaped structure of cobbles and boulders wet-laid in a clay matrix (T. Pozorski 1976). In the course of excavations, small amounts of subsistence remains were uncovered during architectural clearing, and a concentrated 100 cm band of refuse was encountered by two pits very deep in the fill of Huaca Herederos Chica, one of the first mounds constructed. These pits measured 165 cm by 145 cm and 130 cm by 120 cm. Ceramics and other artifactual data as well as radiocarbon dates of 1500 B.C. and 1090 B.C. serve to correlate Huaca Herederos Chica chronologically with the occupation of Gramalote (S. Pozorski and T. Pozorski 1979b).

Although marine products contributed slightly more than half of the animal protein documented by the Caballo Muerto remains, faunal remains from the inland site provide the first evidence of a dietary emphasis on land mammals (Table 5). This combined use by the people of Caballo Muerto of local inland resources and marine fauna makes the site especially significant in this investigation of major shifts in subsistence patterns (S. Pozorski 1976:99-104; S. Pozorski and T. Pozorski 1979b).

Marine shellfish constituted over 50% of the meat volume consumed at Huaca Herederos Chica and thus establish a firm link between the Caballo Muerto complex and the coast. The abundance of these remains at Huaca Herederos Chica indicates that mollusks were the marine resource in greatest demand during the earliest period of the Caballo Muerto occupation. Excavation at other Caballo Muerto mounds also yielded shellfish, suggesting that they persisted as a significant protein source for the duration of the site's occupation.

The large mussel *(C. chorus)* and three large clams *(P. thaca, E. rufa,* and *S. corrugata)* yielded most of the meat, although other small bivalves and gastropods are present. The range of species identified from Caballo Muerto correlates well with the species inventories of both Gramalote and Padre Aban, indicating that Huanchaco Bay was also the source for shellfish consumed at Caballo Muerto.

The frequency of *Scutalus* sp., a land snail, in the Caballo Muerto material suggests that snails were collected for food and provides evidence of the shift away from exclusively marine products. Their use as food is well documented by later Moche period pottery vessels depicting *Scutalus* sp. harvests (Benson 1972:86; Levallee and Lang 1978: 110-111).

Both marine birds and fish were very minor elements in the faunal inventory, and remains of sea lion occurred only sporadically at Caballo Muerto mounds other than Huaca Herederos Chica where it was not present at all. However, these species are significant as evidence of continued contact with the coast.

Deer (probably *Odocoileus virginianus*) furnished almost 20% of the meat volume documented for Huaca Herederos Chica. Near the river, wild plant cover was once probably adequate to provide food and protection for a small number of these animals. Excavations at Huaca Cortada, another very early Caballo Muerto mound, yielded the only other deer bone (T. Pozorski 1976:139). The absence of deer at later mounds indicates that the small local deer population was probably hunted virtually to extinction or displaced by land alteration and deforestation for cultivation very early in the history of Caballo Muerto.

A camelid, probably the domesticated llama *(Lama glama)*, supplied almost as much meat to the Huaca Herederos Chica diet as deer. Evidence suggests that camelids may have been domesticated in the highlands as early as 4400-3150 B.C. (Wing 1973:11-12). Therefore there is little doubt that the camelid identified at Caballo Muerto was introduced into the Moche Valley from the highlands in a domesticated form.

Butchering marks on some of the camelid bones attest to their use as food although they may also have served as beasts of burden, supplied wool, or been used in ceremonial functions. Camelid remains were discovered at several later mounds of the Caballo Muerto complex, a factor which suggests that, unlike deer, camelids persisted as an important meat source.

Dog *(Canis familiaris)* remains were scarcely represented in the Caballo Muerto sample, but their bones document the presence of an additional nonmarine species.

Evidence for irrigation agriculture in the vicinity of Caballo Muerto is indirect because no food plant material was preserved in the Huaca Herederos sample (S. Pozorski 1976:104-106; T. Pozorski 1976:130-131). However, the variety of plant species documented for Alto Salaverry and especially Gramalote indicates that techniques of plant cultivation were well developed by early ceramic times, and a comparable assemblage of species and agricultural skills is assumed for the Caballo Muerto complex. Both the variety and relative quantities of plants known from Gramalote are probably good indications of the species utilized during the concurrent occupation of Caballo Muerto.

Two additional arguments for the existence of an irrigation agriculture base for Caballo Muerto are (1) the large size of the Caballo Muerto complex and (2) its inland location. Certainly floodplain cultivation continued to be practiced in the Moche Valley during the Initial Period and Early Horizon, but the very limited floodplain within the valley precluded the support of a large population based primarily on floodplain agriculture. The size of the mounds within the Caballo Muerto complex, which are significantly larger than any Moche Valley preceramic construction, indicates that a substantial support population was necessary for corporate labor construction projects. Given the inland location of the complex, the only way such a population, estimated to have been at least 1200 people (S. Pozorski and T. Pozorski 1979b:429), could have been supported was by irrigation agriculture.

The settlement shift inland can be correlated with the positioning of canal intakes at points where the steep land gradient makes only short canals necessary to water relatively large areas of land (Willey 1953:392; Farrington 1974:85; S. Pozorski and T. Pozorski 1979b:428-429). Although no canal remains contemporary with Caballo Muerto are preserved, two modern canals have their intakes upvalley and irrigate land adjacent to the Caballo Muerto complex, much in the manner that prehistoric examples probably served the area. Similar arguments for irrigation agriculture based on settlement pattern shifts have been made for other Peruvian coastal valleys (Moseley 1972:41; 1974:78-79) as well as for other areas of the world (Adams 1965; Adams and Nissen 1972).

Early Ceramic Subsistence.—Considered separately, the two Moche Valley early ceramic sites appear very different. Gramalote is a marine-oriented site where shellfish collecting was the major subsistence activity and several food species attained an importance previously documented only for industrial plants. Caballo Muerto, on the other hand, appears anomalous as an inland mound site supported by both inland-derived and marine protein sources and where increasingly efficiently and productive irrigation systems were in operation. Taken together, these two sites emerge as complementary parts of an economic unit, with Gramalote supplying marine products to Caballo Muerto in return for agricultural products from the large areas of land newly opened through irrigation (S. Pozorski and T. Pozorski 1979b).

In contrast to the coastal location and marine subsistence orientation of Padre Aban, Alto Salaverry, and the early ceramic site of Gramalote, the inland location of Caballo Muerto signifies an important change in subsistence priorities. At the three coastal sites, there is a direct correlation between their location and marine subsistence focus. However, the location of Caballo Muerto, predicated on water control as irrigation, documents a new emphasis on inland procurement systems, but not to the extent that marine products were entirely excluded from the diet.

It has been argued on the basis of data from Padre Aban and Alto Salaverry that Cotton Preceramic plant cultivation was concerned mainly with the industrial plants, cotton and gourd. Even at Alto Salaverry with a plant species inventory comparable in many ways to early ceramic sites, food species appear limited in quantity. The circumscribed areal limit of floodplain land is seen as the mitigating factor. Since industrial plants were essential to the predominantly marine economy, they occupied most of the limited Moche Valley floodplain at the expense of food species.

The situation changed markedly in early ceramic times when new areas of land were made arable year-round by canal irrigation. Initially, this shift in subsistence orientation is reflected by settlement relocation well inland to be near canal intakes and irrigated land. Despite the negligible plant preservation at Caballo Muerto, two aspects of the Gramalote sample document a significant quantitative change in the plant species sample. First, food plants other than squash comprised a much greater proportion of the vegetal diet at Gramalote than at either of the Moche Valley Cotton Preceramic sites. Second, a significant seed size increase was observed when squash and gourd seed sizes from Gramalote were compared with the Cotton Preceramic samples (Table 8). This may be correlated with the key advantage of irrigation agriculture. Whereas annual floodplain crops received moisture only briefly once a year in a quantity which was not necessarily adequate for maximum plant growth and fruit maturation, canal irrigation made water available for the duration of the growing season and allowed plants to mature and fully attain their potential size.

The subsistence shift documented by the inland location of Caballo Muerto and the Gramalote plant data represented a physical relocation away from the coastal resources which had traditionally been recognized as the most stable and most abundant. However, ties with the coast were far from completely severed because the inhabitants of Caballo Muerto continued to import marine products. These marine products, mainly shellfish, came from the zone of Huanchaco Bay and were probably made available through the efficient procurement systems in operation at Gramalote in return for vegetal produce from irrigated fields upvalley. In view of the great disparity in site size and complexity between Caballo Muerto and Gramalote, the coastal site may have been a subsidiary community or colony established and maintained to guarantee a reliable supply of marine protein to the large inland site.

Much of the animal protein consumed at Caballo Muerto was not coastal in origin; the earlier occupants of the complex relied heavily on deer and a domesticated camelid. Although deer probably rapidly became virtually extinct locally because of population and agricultural expansion, the domestic camelid increased in importance because it was an inland meat source which was potentially as reliable as shellfish.

CONCLUSIONS

Quantitative subsistence data have been presented for two Cotton Preceramic and two early ceramic sites in the Moche Valley to document two important changes in the early economy of the Andean coast. Three features of the early Cotton Preceramic site of Padre Aban make it transitional in the change from a hunting and gathering to a sedentary coastal lifestyle: (1) its semipermanent appearance which suggests a seasonal

TABLE 8.—*Squash and Gourd Seed Size*

Site	Sample	Length in mm: Average size	Length in mm: Median size	Length in mm: Range	Sample	Width in mm: Average size	Width in mm: Median size	Width in mm: Range
SQUASH								
Padre Aban	9	11.2	11	10-13	9	6.2	6	5- 7
Alto Salaverry	122	11.0	11	8-14	136	6.6	7	5- 8
Gramalote	98	12.5	12	9-17	101	7.7	7	5-12
GOURD								
Padre Aban	—	—	—	—	4	6.5	6	6- 7
Alto Salaverry	47	15.6	15	12-18	75	7.1	7	5- 9
Gramalote	9	16.1	16	15-18	10	7.4	7	7- 8

occupation, (2) substantial remains of birds which could be hunted in the traditional manner, and (3) the collecting, perhaps for the first time, of mollusk species which were the most visible and easily accessible in an area where species with a much higher meat yield could be obtained with more effort. Plant cultigens were very few, and the emphasis was apparently on industrial plants which were indispensible in a maritime economy.

Alto Salaverry exemplifies the end of the Cotton Preceramic continuum as a site which, though principally marine in orientation, was characterized by an extremely varied plant species inventory. Yet, despite this variety, industrial plants continued to dominate the vegetal inventory. The spatial limits on floodplain cultivation is suggested as the key variable, with vital industrial species occupying the limited arable land at the expense of food species.

Although experimentation with canal irrigation may have begun during the late preceramic, the establishment of the inland settlement of Caballo Muerto provides the first evidence of the major subsistence shift away from a reliance predominantly on marine resources. Earlier experimentation with irrigation agriculture was probably motivated by the need for more arable land, perhaps initially still for the production of industrial plants, especially cotton for textiles. By the time Caballo Muerto was constructed, economic priorities had changed to the extent that the major site within the Moche Valley was directly associated with canals and lands newly opened to agriculture and only a subsidiary site remained on the coast. This inland orientation of Caballo Muerto for the fulfillment of subsistence needs is further exemplified by the importance of deer and a domestic camelid, a particularly reliable meat source, to the faunal inventory.

The concurrent existence of Gramalote on the coast, however, attests to a continued reliance on substantial amounts of marine products by the people of Caballo Muerto. The maintenance of such substantial ties to the coast makes Caballo Muerto truly transitional in the early shift to irrigation agriculture. The complementary site of Gramalote is also significant because (1) preserved plant remains document increased cultigen production and yield due to irrigation, and (2) the site can be characterized as a productive economic unit which systematically accumulated products for exchange instead of solely providing for intrasite needs.

Despite the paucity of subsistence studies for other early coastal sites, the data from Huaca Prieta (Bird 1948a; 1948b; Bennett and Bird 1949:88-94; Towle 1961), Huaca Negra (Strong and Evans 1952:17-25, 29-31, 40-41), and Las Haldas (Engel 1957:87; 1970:32; Fung 1969:56-62; Grieder 1975; Moseley 1975:62; Matsuzawa 1978) in combination with the documented presence of inland mounds suggest that the Moche Valley data are not unique. The early emphasis on industrial plants seen at Padre Aban and Alto Salaverry is paralleled by data available for the preceramic component of all three sites, although differential preservation may have biased the sample. As was the case for Gramalote, new plant species were observed in early ceramic deposits at Huaca Prieta and Las Haldas, and there may have been a quantitative increase in plant remains. The coastal orientation of Huaca Prieta, Huaca Negra, and Las Haldas during preceramic times is evident from the faunal remains from each site, and the species inventories suggest that procurement activities closely paralleled Moche Valley examples. By early ceramic times at Huaca Negra and Las Haldas, concentrations of the remains of a few species of shellfish or fish provide the best evidence that the sites had became more specialized and efficient procurement and processing centers like Gramalote.

In all three valleys where coastal sites have been tested, there are inland mounds or mound complexes which may have formed part of an economic unit similar to the Caballo Muerto/Gramalote symbiosis (Kosok 1965:194; T. Pozorski 1976:282-283; S. Pozorski and T. Pozorski 1979b). Jaguey in the Chicama Valley may have interacted with Huaca Prieta. Huaca el Gallo and Huaca la Gallina may have depended on Huaca Negra for shellfish in return for cultivated plant products and the sacrificial llamas at the Temple of the Llamas. Inland early ceramic sites in the Casma Valley are particularly numerous, but Sechin Alto, Sechin Bajo, and Taukachi-Konkan are architecturally most similar to Las Haldas (Fung and Williams 1977) and therefore were probably the sites which were connected economically with the coastal site. All the coastal sites, even Las Haldas, appear subsidiary in size and complexity when compared with their postulated complementary inland sites.

ACKNOWLEDGMENTS

Excavations at Padre Aban, Alto Salaverry, Gramalote, and Caballo Muerto were conducted in 1973 and 1974 under the auspices of the Chan Chan-Moche Valley Project directed by C. J. Mackey and M. E. Moseley and with the permission of the Peruvian Instituto Nacional de Cultura. Funding was provided by the National Science Foundation, the National Geographic Society, and the Institute of Latin American Studies of the University of Texas at Austin.

LITERATURE CITED

ADAMS, ROBERT MCC. 1965. Land behind Baghdad. A history of settlement on the Diyala plains. Univ. Chicago Press, Chicago.

ADAMS, ROBERT MCC. and HANDS J. NISSEN. 1972. The Uruk countryside. The natural setting of urban societies. Univ. Chicago Press, Chicago.

BEGLER, ELSIE B. and RICHARD W. KEATINGE. 1979. Theoretical goals and methodological realities: problems in the reconstruction of prehistoric subsistence economies. World Arch. 11(2):208-226.

BENNETT, WENDELL C. and JUNIUS B. BIRD. 1949. Andean culture history. Amer. Mus. Nat. Hist., New York.

BENSON, ELIZABETH P. 1972. The Mochica, a culture of Peru. Praeger, New York.

BIRD, JUNIUS B. 1948a. America's oldest farmers. Nat. Hist. 57:296-302, 334-335.

———. 1948b. Preceramic cultures in Chicama and Viru. Pp. 21-28 *in* A reappraisal of Peruvian archaeology (assembled by Wendell C. Bennett). Mem. Soc. Amer. Arch. 4.

CARDOZA G., ARMANDO. 1954. Los auquénidos. La Paz.

CARSON, RACHEL. 1955. At the edge of the sea. New American Library, New York.

COHEN, MARK N. 1975. Some problems in the quantitative analysis of vegetable refuse illustrated by a Late Horizon site on the Peruvian coast. Ñawpa Pacha 10-12:49-60.

ENGEL, FREDERIC. 1957. Sites et établissments sans céramique de la côte peruvienne. Journal de la Société des Americanistes, New Series 46:67-155.

———. 1970. Las lomas de Iguanil y el complejo de Haldas. Universidad Agraria, Lima.

EVERMANN, B. and L. RADCLIFFE. 1917. The fishes of the west coast of Peru and the Titicaca Basin. Bull. U.S. Natl. Mus. 95.

FARRINGTON, IAN. 1974. Irrigation and settlement pattern: preliminary research results from the north coast of Peru. Pp. 83-94 *in* Irrigation's Impact on Society (T. E. Downing and McG. Gibson, eds.). Anthrop. Papers Univ. Arizona 25, Tucson.

FITCH, JOHN E. 1953. Common marine bivalves of California. State of California Dept. Fish and Game Marine Fisheries Branch Fish Bull. 90.

FUNG, ROSA. 1969. Las Aldas: su ubicación dentro del proceso histórico del Peru antiguo. Dédalo 5(9-10). Museu de Arte e Arqueologia, Universidade de Sao Paulo.

GRIEDER, TERENCE. 1975. A dated sequence of building and pottery at Las Haldas. Ñawpa Pacha 13:99-112.

HILDEBRAND, S. 1946. A descriptive catalog of the shore fishes of Peru. Bull. U.S. Natl. Mus. 189.

KEEN, A. MYRA. 1971. Sea shells of tropical west America, second edition. Stanford Univ. Press, Stanford.

KOSOK, PAUL. 1965. Life, land and water in ancient Peru. Long Island Univ. Press, New York.

KOSTRITSKY, LEON. 1963. Los mamíferos marinos de importancia económica. Pp. 23-40 *in* Recursos naturales del mar. Servicio de Pesqueria del Ministerio de Agricultura y la Facultad de Ciencias de la Universidad Nacional Mayor de San Marcos. Imprenta de la Universidad de San Marcos, Lima.

LEVALLEE, JOSE A. DE and WEINER LANG. 1978. Arte precolombino, segundo parte: escultura y diseño. Banco de Crédito del Peru, Lima.

MACNEISH, RICHARD S. 1967. A summary of the subsistence. Pp. 290-309 *in* The prehistory of the Tehuacan Valley, Vol. 1 (D. S. Byers, ed.). Univ. Texas Press, Austin.

MATSUZAWA, TSUGIO. 1978. The Formative site of Las Haldas, Peru: architecture, chronology, and economy (trans. by Izumi Shimada). Amer. Antiquity 43:652-673.

LITERATURE CITED (continued)

MOSELEY, MICHAEL E. 1972. Subsistence and demography: an example of interaction from prehistoric Peru. Southwestern J. Anthr. 28(1):25-49.

__________. 1974. Organizational preadaptation to irrigation: the evolution of early water management systems in coastal Peru. Pp. 77-82 *in* Irrigation's Impact on Society (T. E. Downing and McG. Gibson, eds.). Anthrop. Papers Univ. Arizona 25, Tucson.

__________. 1975. The maritime foundations of Andean civilization. Cummings Publ. Co., Menlo Park, California.

OLSSON, AXEL A. 1961. Mollusks of the tropical eastern Pacific: Panamic-Pacific pelecypoda. Paleon. Res. Inst., New York.

PICKERSGILL, BARBARA and RICHARD T. SMITH. 1981. Adaptation to a desert coast: subsistence changes through time in coastal Peru. Pp. 89-115 *in* Environmental Aspects of Coasts and Islands (D. R. Brothwell and G. W. Dimbleby, eds.). Symposia, Assoc. Environmental Arch. 1.

POZORSKI, SHELIA. 1976. Prehistoric subsistence patterns and site economics in the Moche Valley, Peru. Unpubl. Ph.D. dissert. (Anthr.). Univ. Texas, Austin.

POZORSKI, SHELIA and THOMAS POZORSKI. 1977. Alto Salaverry: un sitio precerámico de la costa peruana. Revista del Museo Nacional 43:27-60.

__________. 1979a. Alto Salaverry: a Peruvian coastal preceramic site. Annals Carnegie Mus. Nat. Hist. 49:337-375.

__________. 1979b. An early subsistence exchange system in the Moche Valley, Peru. J. Field Arch. 6:413-432.

POZORSKI, THOMAS. 1976. Caballo Muerto: a complex of early ceramic sites in the Moche Valley, Peru. Unpubl. Ph.D. dissert. (Anthr.). Univ. Texas, Austin.

RICHARDSON, JAMES B., III. 1981. Modeling the development of sedentary maritime economies on the coast of Peru. Annals Carnegie Mus. Nat. Hist. 50:139-150.

STRONG, WILLIAM D. and CLIFFORD EVANS. 1952. Cultural stratigraphy in the Viru Valley, northern Peru. Columbia Univ. Studies in Arch. and Ethn. 4.

TOWLE, MARGARET A. 1961. The ethnobotany of pre-Columbian Peru. Viking Fund Publ. Anthr. 30. Wenner-Gren Found. Anthrop. Res., New York.

WHITE, THEODORE E. 1953. A method of calculating the dietary percentages of various food animals utilized by aboriginal people. Amer. Antiquity 18(4):396-398.

WILLEY, GORDON R. 1953. Prehistoric settlement patterns in the Viru Valley, Peru. Bur. Amer. Ethn., Smithsonian Inst. Bull. 155, Washington, D.C.

WING, ELIZABETH S. 1973. The origins of agriculture: animal domestication in the Andes. Paper, 9th Internatl. Congress Anthrop. and Ethnol. Sci., Chicago.

J. Ethnobiol. 3(1):39-48 May 1983

POLLEN FROM ADOBE BRICK

MARY KAY O'ROURKE
Department of Geosciences, University of Arizona
Tucson, AZ 85721

ABSTRACT.—Pollen from adobe bricks of the historic Brockman house of Tucson, Arizona, provides clues to the construction history of the building. Seventeen pollen samples were obtained from two separate walls and the mortar joining the bricks of one wall. The cheno-am pollen type is dominant in all samples, and its proportion and concentration are significantly different between the two walls as indicated by chi square contingency tests. Similar differences are seen in high spine Compositae, *Ambrosia* type, Gramineae, Leguminosae, *Pinus* and in the AP:NAP ratio. *Salsola* type pollen was differentiated from other cheno-am pollen in this study. It was present in all adobe brick but it was rare or absent in the clay rich mortar. The variability among three samples from a single adobe brick is not statistically significant. Chi square contingency tests indicate similarity between modern soil (S_2) and the adobe of wall I. The adobe of wall II was distinctly different from the modern soil. Chi square contingency tests also indicate similarity in pollen content of mortar and wall II, and significant differences between pollen content of mortar and wall I. Pollen content in the adobe brick can be interpreted as indicating two building phases for the house. Historic records indicate the earliest construction postdated 1901. Therefore, *Salsola* invasion into the area must predate 1901 based on this pollen evidence.

INTRODUCTION

Pollen analysis has long been used by investigators in an archaeological context throughout the southwest to ascertain: (1) diet (Martin and Sharrock 1964; Kelso 1970, 1976; Bryant 1974), (2) seasonality of site occupation (Kelso 1970), (3) land use (Webb and Solomon 1974), and (4) environmental change (Martin 1963). Recent historic changes in the vegetation of urban Tucson have also been documented using pollen analysis as a tool (Solomon and Hayes 1980). The overall technique has proved valuable for the investigation of past events. This technique can be used to investigate another type of event—that of construction sequence in adobe buildings.

Adobe structures are frequently built in stages. Many times color differences are apparent in the adobe bricks, different types of mortar are used during different building phases, or adjacent walls are not properly joined and wall separation occurs between rooms of different building episodes. These differences are clues to the building sequence of the individual structure.

Adobe construction is common in the arid southwestern United States, as well as in other arid portions of the world. Seventeen samples from the adobe of the historic Brockman house located at 420 East 18th Street in the Armory Park neighborhood of Tucson, Arizona were collected and analyzed for pollen content. Most of the homes in this neighborhood were built for families of railroad workers around the turn of the century. Many are made of fired brick; a few are made of mud adobe brick. Twelve of these samples were taken from 10 different adobe bricks. The other five samples were taken from mud mortar. This study was performed to determine: (1) if pollen is preserved in adobe, (2) if different source areas for raw materials or periods of building are reflected in the pollen content of the adobe, (3) the variability of pollen content within a single brick, (4) if the season of construction can be determined from the pollen content of the adobe. Although it was not one of the goals of this study, the pollen data obtained provided information regarding the appearance and spread of a plant species introduced to the United States in historic time.

HISTORY OF ADOBE AND ADOBE RESEARCH IN THE SOUTHWEST

Use of adobe in construction is varied. Judd (1916) reports that it was used as a mortar between stones, as a plaster over wood and as massive *in situ* mud wall construction (caliche) before the Spanish ventured into the Southwest in 1540 A.D. Evidence for prehistoric construction using adobe brick is rare but not unknown. Morris (1944) reports one prehistoric experiment in the use of mud "bricks" near Aztec, New Mexico. These bricks fractured because no straw or organic matter were added to them; this lack resulted in shrinkage during the drying process. The resulting broken and whole bricks of variable sizes were used to build the walls of a kiva. The building could not have predated 1097 A.D. according to tree ring dates obtained from wood taken out of the ruins of the kiva. Pottery associated with the building and correlated with tree ring dates from other sites supports a date of 1110-1121 A.D.

An adobe brick wall was also found in an upper Gila pueblo. At this site true rectangular bricks were used. They were placed in the wall while still partially wet and as a result each brick is fused to the bricks adjacent to it. Danson (1957:84) states, "This is one of the few recorded finds of bricks used in a prehistoric dwelling in the Southwest."

The Spanish used adobe bricks in construction of their numerous missions. Use of adobe brick spread rapidly, and in 1879 when Anita Rose visited Tucson she was both impressed and shocked by the "gloomy adobe" buildings. She described the adobe as an " . . . ad-mixture of mud and water with a little cut straw, mixed and molded in wooden frames, brick shaped but more oblong, say 1 x 1½ feet and 4 inches thick" (Rose 1879: 23). She further relates that "They (adobe bricks) are laid as bricks and plastered with a similar substance barring the straw and burned by the sun." Many early adobe bricks were made at the site of construction from the surface soils. Another source of adobe brick was the commercial brickyard. Newspaper accounts from the period tell of contracts for making adobe brick being awarded to Lord and Williams (Arizona Weekly Citizen 1873, Oct. 4 and 11). The 1881 city directory (Barter 1881) records two brickyards in Tucson, one was at Silver Lake and the other was probably at or near Warner's Mill. Both were west of town in the floodplain of the Santa Cruz River.

Studies conducted earlier in the century (Hendry and Kelly 1925; Hendry 1931) utilized adobe bricks as a source of macrofossils to determine the time of introduction of agricultural plants and exotic weedy species into Arizona, California, and Sonora, Mexico. Adobe bricks were obtained from old buildings and missions, dissolved in water and the macrofossils were identified. Montgomery et al. (1949:138) reported that Volney Jones identified the " . . . fibrous reinforcements contained in the adobe bricks" from the 17th century Spanish mission at Awatovi in northeastern Arizona. Studies conducted on adobe brick thus far have centered on the study of plant macrofossils. This study examines microfossils (pollen) contained in adobe.

METHODS

Modern construction techniques serve as the basis for the sampling scheme employed in this study. In Tucson, modern adobe brick is made from a mud mixture poured into wooden forms and sun dried. Then the forms are removed, and the bricks are stacked on pallets. Bricks from the same mud lot generally end up on the same pallet, and they are generally delivered to the same construction site. Hoddies carry mortar and bricks to the mason. Hoddies usually empty the pallets one at a time and removed them from the site. Modern adobe walls are generally built in horizontal tiers, with bricks from one lot in the same tier. Assuming that the same construction techniques were used at the turn of the century, historic adobe bricks separated vertically are more likely to represent different lots. Consequently, historic adobe samples from a vertical sequence were collected to maximize differences in the source of the bricks.

Pollen samples were collected from ten adobe bricks in two different walls which appear visually distinct (Fig. 1). Color differences occur in the adobe bricks and composition differences occur in the mortar. Mrs. Elsa Hanna Wright (nee Borckman), the former owner, recalled her mother saying one room of the house was older than the others. Thus, the interview supports a conclusion of two phases of building construction as employed by the visual differences in the building materials.

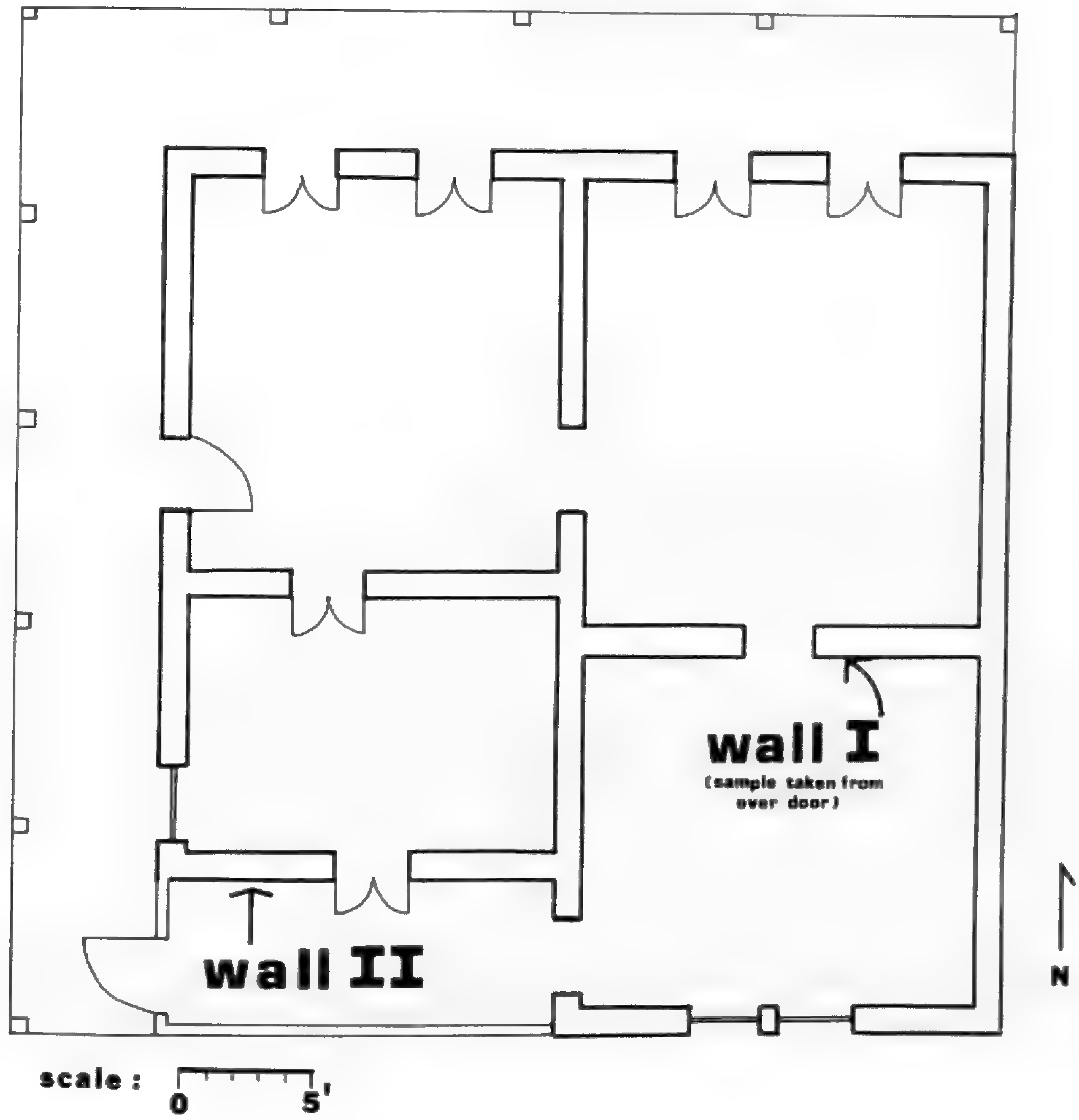


FIG. 1–Floor plan of the Brockman House, Tucson, Arizona and locations where pollen samples were collected.

Adobe bricks exposed during building repair were wetted and their surfaces were scraped to eliminate surface contamination by modern airborne pollen. Subsequently, samples were collected by chiseling about 30 g of material from each adobe brick or mortar seam (see Fig. 1 for sample location.) Three samples were taken from a single brick exposed in a doorway of wall II to test for homogeneity. For comparative purposes, a modern soil sample was obtained from an adjacent vacant lot and collected using the pinch method described by Adam and Mehringer (1975). All samples were collected during the month of January 1981 thus minimizing potential contamination from flowering plants.

Known quantities of *Eucalyptus* sp. (eucalypt) pollen were added to each sample as a tracer for quantitative analysis (Stockmarr 1971). *Lycopodium* spores might prove a better tracer for future use because several species of *Eucalyptus* are planted as ornamental trees in Tucson. Only a few *Eucalyptus* trees currently grow in the neighborhood and both were planted long after 1910. Rogers (1979) discusses cultivated plants commonly used in Tucson during its early history and no mention is made of *Eucalyptus*. He also states that most exotic landscape plants arrived in Tucson after 1920. Modern airborne data (Solomon and Hayes 1972) reflect some *Eucalyptus* pollen in the area of the Tucson Clinic, but that is a local effect (O'Rourke 1980) of trees planted in the neighborhood during the 1930's and 40's. Other airborne pollen studies conducted in neighborhoods with few *Eucalyptus* trees show no more than 20 *Eucalyptus* grains captured by volumetric sampling for the entire year (O'Rourke, unpubl.). Although *Eucalyptus* is not the best tracer, it is certainly adequate, especially for samples from the Tucson area predating 1920. Pollen was extracted from all samples using the HC1 swirl and standard chemical techniques including treatment with HF, HNO_3, and KOH as described by Mehringer (1967).

Pollen stained with Safranin 0 was mounted on slides in glycerine, examined with a microscope, and minimum counts of 200 grains were obtained for all samples. Routine pollen counts were made scanning at 390 x with occasional identification of difficult grains attempted at 1560 x under oil immersion. *Salsola* (tumbleweed) pollen was separated from other cheno-am [Chenopodiaceae (Goosefoot) and *Amaranthus* (Pigweed)] types primarily on the basis of number and structure of pores, and secondarily on the basis of the wall structure between adjacent pores. At high focus only 9 pores can be seen clearly in *Salsola.* Most *Amaranthus* and many Chenopodiaceae have a larger number of pores visible at high focus. In addition, the pores of *Salsola* are depressed, not annulate, as are those of *Sarcobatus. Salsola* also has elements in each pore. The wall between pores is scabrate having generally fewer elements than most other cheno-am type pollen grains. Based on these characteristics *Salsola* can be separated from the 8 *Amaranthus* spp. and 26 Chenopodiaceae types in the University of Arizona Pollen Reference Collection (Kapp 1969; Martin and Drew 1970).

RESULTS

Pollen-percentage values were calculated for all pollen types and appear with confidence intervals (Maher 1971) for major types in Fig. 2. Samples 1-4 were all obtained from the light colored adobe bricks held by a mud mortar and designated as wall I. These samples were taken from the north wall of the SE room above the door in vertical sequence. Samples 5-9 were obtained from the same location but are from the mud mortar which joined the bricks vertically. Samples 10-14 were obtained from the darker adobe bricks making up the south wall of the southwest room designated as wall II. These bricks were held together by a high lime and sand mortar. Samples 15-17 were all taken from the same brick in wall II and sample 18 is a modern soil surface sample taken from soil adjacent to the house (Fig. 1).

Adobe and mortar samples contain from 67-93% cheno-am pollen type. This is the most prevalent pollen type found in all samples (Fig. 2). The cheno-am type is carried by

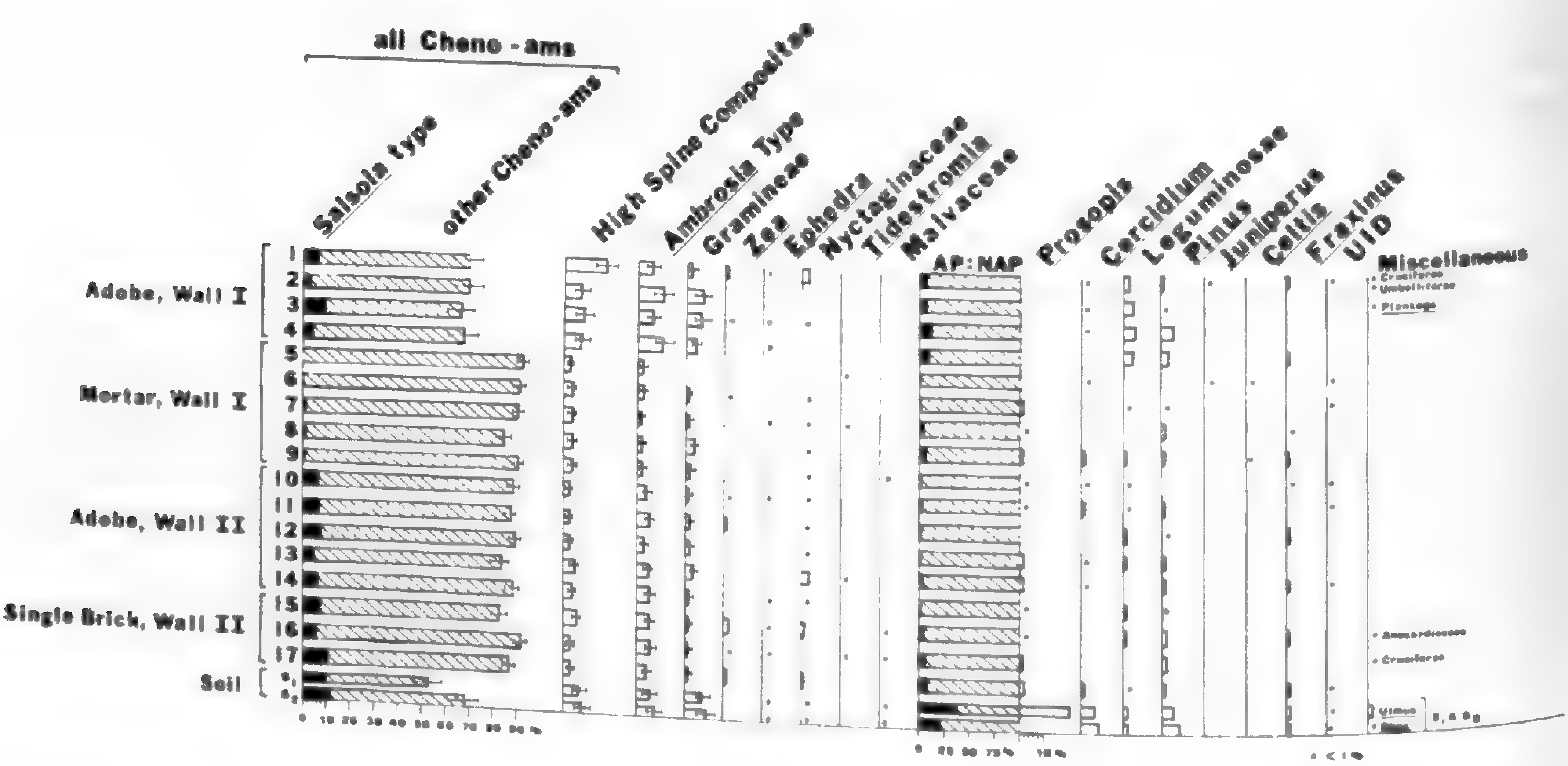


FIG. 2–Relative pollen frequencies and selected 95% confidence intervals for adobe, mortar and soil. Brockman House, Tucson, Arizona.

the wind (Solomon 1979) and resistant to degradation (Hall 1981). High cheno-am concentrations are associated with disturbed soils like those of floodplains (Martin 1963). Confidence intervals associated with cheno-am values from wall I do not overlap with those of any other samples taken from the structure. Cheno-am values for wall I range from 67-70% and are significantly lower than concentrations from the mortar samples (85-93%) and from the samples of wall II (84-90%). *Salsola* is recorded as the black portion of the cheno-am curve in Fig. 2. The adobe samples from both walls have approximately equal amounts of *Salsola* pollen, whereas mortar samples from wall I have appreciably less.

Adobe samples from wall I have higher values of *Ambrosia* (ragweed), high spine Compositae (i.e. *Erigeron,* etc.), Gramineae (grass), and some members of the Leguminosae (pea family, excluding *Acacia, Mimosa, Prosopis* and *Cercidium)* than wall II. *Pinus* (pine) and the AP:NAP (arboreal pollen: nonarboreal pollen) ratio are also slightly higher in adobe samples from wall I.

The lack of overlapping confidence intervals for the principal pollen type (cheno-am) of wall I and wall II suggest different source material for the adobe of the two walls. Mean percentage values for the ten principle pollen types [cheno-am, high spine Compositae, *Ambrosia,* Gramineae, *Ephedra* (mormon tea), Nyctaginaceae (four o'clock family), Leguminosae, *Pinus, Cercidium* (palo verde), and *Fraxinus* (ash)] of each wall were transformed using an arc sine function. A chi square contingency test was used between transformed mean values for the two walls (Sokal and Rohlf 1969). Test results indicate that the pollen content in the adobe of wall I is significantly different (.05 level) from the pollen content in the adobe of wall II.

Mortar samples joining adobe bricks in wall I have cheno-am values that exceed 90% of the total pollen present in 4 of the 5 samples collected. The 95% confidence intervals of cheno-am values from the mortar of wall I overlap with the cheno-am confidence intervals associated with adobe samples from wall II. There is no significant (.05 level) difference within the cheno-am values from the mortar samples and wall II even though the percentages in the wall are lower.

Ambrosia pollen content in the mortar is lower than the *Ambrosia* pollen content found in the adobe of wall II. This in turn is lower than the *Ambrosia* pollen content found in wall I. Pollen content in the mortar of wall I and the adobe of wall II are about the same for high spine Compositae, but pollen values of both taxa are lower than those of the adobe of wall I. The same relationship holds for the Gramineae values.

Pollen types that occur in the adobe and mortar samples in less than 3% include *Zea* (corn), Nyctaginaceae, *Cercidium,* and *Fraxinus.* Pollen from *Ephedra, Plantago* (plantain), Malvaceae (mallow), *Juniperus* (juniper), *Celtis* (hackberry), Anacardiaceae (cashew family), *Tidestromia* (tidestromia), and the Umbelliferae and Cruciferae (carrot and mustard families) are all present in less than 1% in adobe and mortar samples.

Chi square contingency tests were calculated in the same manner as above among the adobe of wall I, wall II, and the mud mortar of wall I. Significant differences (.05 level) exist between wall I and the mud mortar joining wall I.

Samples 15, 16, and 17 were all taken from the same brick in wall II to test the homogeneity of pollen by type and amount. Comparisons among all taxa at the 95% confidence level overlap except the cheno-am values between samples 15 and 16. Chi square contingency tests were calculated in the same manner as above among the three samples. All three values were significant (.05 level) indicating homogeneity among the samples from a single brick.

The modern soil sample at the site shows a significantly (.05 level) lower cheno-am value and higher *Prosopis* (mesquite) value than seen in the adobe samples. This may be due to the influence of locally produced pollen from vegetation growing at or near the site today. Such localized effects of pollen over-representation have long been recognized by palynologists (Tauber 1965; Janssen 1966, 1967; Leuschner and Boehm 1977). Plants growing at or near the Brockman house today include *Prosopis velutina* (velvet mesquite), *Parkinsonia aculeata* (Mexican palo verde), *Fraxinus velutina* (velvet ash), *Ulmus pumila* (Siberian elm), *Rhus lancea* (South African sumac), *Pinus halepensis* (Aleppo pine) and some Gramineae (grasses). Neither *Prosopis velutina* nor *Ulmus pumilia* trees occur in a 1907 photo of the site. Local pollen production varying with time accounts for the presence of *Prosopis* pollen in the modern soil. If *Prosopis* is excluded from the pollen sum, then the cheno-am value returns to 68% of the remaining pollen present (n changes from 259 to 203). Therefore, Fig. 2 has two soil spectra; one includes *Prosopis* in the pollen sum (S_1), the other excludes *Prosopis* from the pollen sum (S_2). No significant (.05 level) differences are seen between the adobe sample from wall I and the pollen spectrum of the soil sample as depicted (S_2). All confidence intervals overlap for major pollen types and chi square analysis conducted as above for 6 major NAP types (Cheno-am, *Ambrosia*, high spine Compositae, Gramineae, *Ephedra*, Nyctaginaceae) indicate a significant similarity (.05 level) between pollen of the modern soil (S_2) and pollen from the adobe of wall I.

Pollen concentrations expressed in grains/gram are illustrated with confidence intervals (Maher 1971) in Fig. 3. Pollen concentration in wall I is relatively low ranging from 3,602 to 4,584 grains/gram. Pollen concentrations obtained from the mortar of wall I and from the adobe of wall II are a great deal more variable and are much higher (28,593 to 151,484 grains/gram). The disparity between pollen concentrations of the two walls again suggest either differences in the source material of the adobe or differences in building episodes.

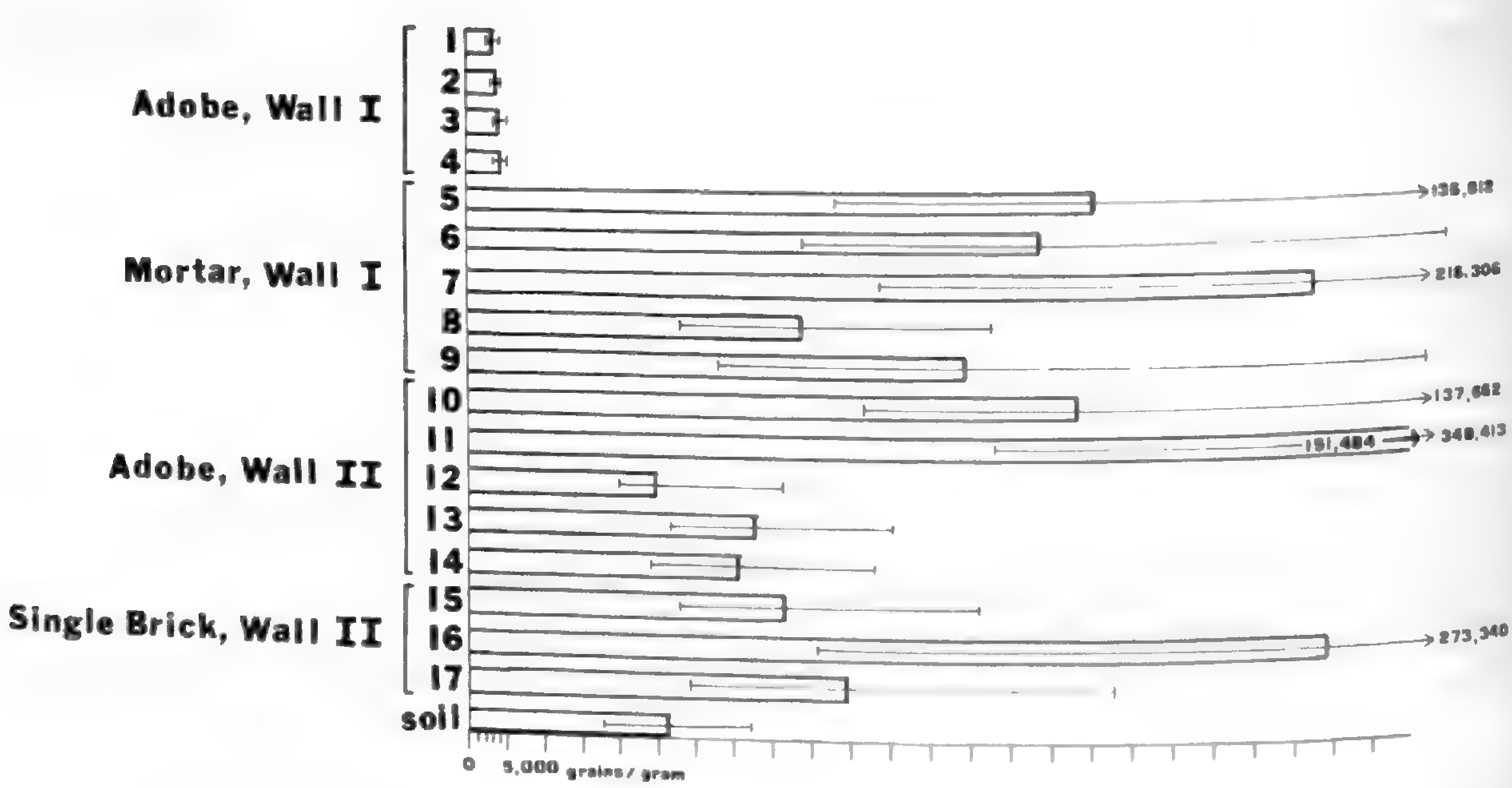


FIG. 3–Pollen concentration in grains/gram for adobe, mortar and soil Brockman House, Tucson, Arizona.

DISCUSSION

The primary purpose of this research was to determine whether adobe bricks contain pollen. Consequently, only a limited number of pollen samples were collected. In these, I found pollen in countable numbers in both adobe brick and mortar. Perhaps the pollen is preserved because the adobe is kept dry (under plaster).

The second goal of this paper was to determine whether different source areas of raw material or different building episodes could be determined using pollen analysis as a tool. These two questions are related. From other evidence at the Brockman house (historic records, interviews, wall separation due to poor wall joints, differences in mortar composition and variability in adobe color and texture) a conclusion of two phases of building construction is probable. The pollen spectra of the two walls investigated adds additional evidence to support such a conclusion. Differences in the pollen spectra are a function of the pollen incorporated in the adobe. If the same sources of raw materials were utilized and combined in the same proportion during each phase of construction, then no differences would be seen among the pollen spectra of the two walls examined. Conversely if different sources of raw materials were selected during a single building phase then the resulting differences in the pollen spectra have a different meaning. As with paleoecologic studies, all evidence must be considered in concert before a conclusion is formulated.

Interpretation of the pollen spectra obtained from adobe brick is complex due to the variety of pollen sources contributing to the pollen spectra of the adobe. To examine the biases inherent in a sample of this type a hypothetical scenario of pollen sources contained in adobe brick is examined. Major pollen sources, in this scenario, include: (1) pollen contained in the soil or alluvium making up the 'mud' of the adobe, (2) pollen adhering to or contained in tempering material like 'straw' or manure added to the mud mixture, (3) pollen contained in the water added to the soil or alluvium to make the 'mud', and (4) atmospheric pollen incorporated in the mud while the wet adobe is mixed and drying. Additional assumptions must be made regarding the proportion of each component to the adobe mixture. Values of 30% tempering material and 5 l of water per adobe brick are probably excessive based on observation of modern adobe mixtures. These numbers provide an upper limit for pollen contributed from these sources.

Studies conducted in southern Arizona demonstrate the prolific occurrence of pollen in samples of surface soil (Hevly et al. 1965; Adam and Mehringer 1975) and alluvial deposits (Martin 1963), but these studies do not contain pollen-concentration values. Soils in the Tucson area have variable pollen concentrations depending on the surrounding vegetation. Pollen concentrations as low as 2,000 grains/g or concentrations as high as several million pollen grains/g soil can occur (O'Rourke, unpubl. data). For the purpose here, soil pollen concentration is 26,000 grains/g; this is the pollen concentration of the modern surface soil at the site today.

Pollen contained in the tempering material is also variable. Reliable pollen concentrations for the amount of Gramineae pollen per gram of plant are not available in the literature. Pollen contained in the manure will reflect the diet of the animal producing the manure (Martin and Sharrock 1964; King 1977). The primary feed of horses and cows is grass obtained either as hay or free range grazing. A single horse dung ball chisseled from an adobe brick in the Tucson Barrio contained 75% Gramineae pollen and 14,400 pollen grains/g dung. The Gramineae pollen in an adobe sample may be a function of pollen content in the manure or pollen adhering to the straw (Tauber 1965). Gramineae inflorescences are also added to the adobe with the straw component. The presence of the *Zea* could be accounted for as a portion of the tempering material, especially since its pollen has a short airborne range (Raynor et al. 1972). This means that the Gramineae (including *Zea)* concentrations probably do not include useful interpretive information.

Pollen contained in surface water could potentially contribute a large amount of pollen to adobe. Martin (1963) reported high concentration of *Pinus* pollen in flood water scum collected in August 1959. Over 4900 pollen grains were counted on a single slide. Solomon and Hayes (1972) indicate peak airborne pollen concentrations for native *Pinus* species in mid-June with low airborne Pinus concentrations persisting through late August in the Tucson area. Pollen input from surface water would vary seasonally, with storm intensity and with storm frequency. Numerous studies in temperate areas report variation in pollen concentration in streamflow (Crowder and Cuddy 1973; Peck 1973; Bonny 1976; Starling and Crowder 1980). The seasonal similarity between flowering plants and pollen content in water is demonstrated by Bonny (1976), and Peck (1973). Inferences drawn from the research conducted by Martin (1963) and Solomon and Hayes

(1972) suggest that this pollen source could contain the greatest potential for revealing time of adobe fabrication. Maximum pollen concentrations obtained by Starling and Crowder (1980) in a temperate region were 600 pollen grains/l water. Pollen concentrations in river water of temperate environments should be much higher than those of the Tucson area. Pollen captured by stream water in temperate environments is generated from a predominantly wind pollinated flora which, due to this mechanism of pollination, will produce larger amounts of pollen than the predominantly insect pollinated flora of the desert southwest (Solomon and Hayes 1980).

Atmospheric pollen incorporated in the adobe mud at the time of mixing will be relatively minimal and will vary seasonally by type and amount. Monthly atmospheric pollen concentrations per cm^2 for urban Tucson from 1954-1970 ranged from a maximum of 400 grains in March to a minimum of 25 grains in the month of December (Solomon and Hayes 1972). This averages about 13 pollen grains/cm^2/day at a maximum and less than 1 pollen grain/cm^2/day at a minimum. Obviously this will not be a major contribution to the pollen contained in adobe brick or mortar.

A single adobe brick from the Brockman house weighed 20.96 kg. Based on the composition assumptions and the pollen concentration values for each source as given above then the brick contains 14,672 g of soil and 6,288 g of temper. Thus, a single adobe brick could contain 381,472,000 pollen grains from the soil, 90,547,200 pollen grains from manure temper, 3,000 pollen grains for 5 l water and 540,000 grains of atmospheric pollen over the entire surface of a drying adobe brick. Each adobe brick will contain 472,562,200 pollen grains per adobe brick. The major pollen contribution to adobe comes from the soil (81%). The temper (manure) component contributes nearly 19% and the remaining pollen (1%) is contributed from the air and water (.1% from air; .0006% from water). Thus, the overall pollen spectra, eliminating the Gramineae and *Zea* curves, will reflect the pollen spectra of the soil component.

Pollen concentration in adobe is variable, and it will be dependent on the components of that adobe as discussed above. Marked variation in pollen concentration may delineate one adobe building episode from others. In this study, adobe of wall I has far lower pollen concentration than adobe of wall II. In addition, the relative concentration of cheno-am type pollen is significantly (.05 level) less in wall I than in wall II. Such a difference is consistent with two phases of building construction, which can also be seen in mortar differences, adobe color changes, structural discontinuity and verbal accounts of prior owners. Because the pollen of the brick is derived chiefly from the soil material, these differences point to adobe obtained from two different source locations.

The third goal of this study relates to methodology. Three samples taken from a single adobe brick reflect essentially the same pollen spectra. Three samples are statistically a small number of replicate samples, but they do suggest homogeneity of pollen distribution within a single brick.

The last goal of the study addresses the question of identifying seasonality from pollen contained in the adobe brick. The scenario discussed earlier demonstrates that seasonal input from airborne or waterborne pollen sources makes up less than 1% of the pollen incorporated in an adobe brick. As a result the likelihood of obtaining reliable seasonal information from the pollen contained in adobe brick is low.

Other information regarding the spread of non-native plants in the southwest is also contained in adobe brick. In this instance plant macrofossils may provide the best information since they can frequently be keyed to the species level. Adobe brick can serve as a time capsule whether for micro- or macrofossils since additional pollen or plants cannot penetrate beyond the surface of the brick once it has dried. Therefore, the pollen or plants contained in the brick cannot postdate the building's construction, and so pollen and plants from the adobe can be indicators of local vegetation at the time of construction. Thus, comparisons between pollen spectra of adobe brick and modern soils may also provide an indication of how man has modified his environment since the period of construction.

Salsola pollen occurs in all adobe brick samples examined but not in all mortar samples. From this data it is safe to assume that the adobe brick used in this house was manufactured after *Salsola* invaded the Tucson area. The earliest known record of *Salsola kali* in Tucson is a specimen collected by J.W. Toumey on July 31, 1892 from a local garden (Univ. of Ariz. Herb. Spec. No. 44358). Historical records indicate the earliest construction of the Brockman house postdates 1901. By this time *Salsola kali* must have occurred commonly to provide pollen percentages comparable with those of modern soil. Future research using pollen in adobe brick may give an idea of the speed with which *Salsola* spread in Tucson.

The scarcity of *Salsola* pollen is the only significant difference between the pollen spectra of the mud mortar joining wall I and the pollen spectra of the adobe of wall II. *Salsola* pollen is in the adobe brick of wall I although much reduced in the mortar which was mixed at the time of construction. This means that although *Salsola* plants were assumed to be prevalent at the time of construction, their pollen was barely present in mortar dating from the period. I propose that the mortar may have quarried from alluvium deposited prior to significant *Salsola* invasion, and that it may have come from a different site than the bricks from the same wall.

The initial goals of this study were more than fulfilled and useful information was obtained to help interpret the history of the Brockman house. The method has potential for use on other buildings in Tucson as an aid in historical research. Future work may also yield additional data on the spread of exotic weedy species like *Salsola*. Studies of this type carried on in other areas must be related to the history and vegetation of that area.

ACKNOWLEDGEMENTS

This research was inspired although not funded under the auspices of Historic Preservation Fund Grant SP8020. Many thanks to Robert Thompson, R.B. Brown, Sue Fish, Adrianne Rankin, Gloria Fenner, Paul S. Martin and Owen K. Davis for critical review of the manuscript. Adrianne Rankin, Deborah Gaines, and Helen G. O'Rourke typed the manuscript at various stages and many, many thanks go to them.

LITERATURE CITED

ADAM, D.P. and P.J. MEHRINGER, JR. 1975. Modern pollen surface samples: an analysis of subsamples. J. Research, U.S. Geol. Survey 3:733-736.

ARIZONA WEEKLY CITIZEN, 1873. Oct. 4.

ARIZONA WEEKLY CITIZEN, 1873. Oct. 11.

BARTER, G.W. (compiler). 1881. The directory of the city of Tucson for the year 1881. G.W. Barter, H.S. Crocker and Co., San Francisco, p. 114.

BONNY, A.P. 1976. Recruitment of pollen into the seston and sediment of some Lake District lakes. J. Ecology 64:859-887.

BRYANT, V.M. 1974. Prehistoric diet in southwest Texas: the coprolite evidence. Amer. Antiquity 39:407-420.

CROWDER, A.A. and D.G. CUDDY. 1973. Pollen in a small river basin: Wilton Creek, Ontario. Pp. 61-77. Quaternary Plant Ecology. (H.J.B. Birks and R.G. West, eds.). Blackwell, Oxford.

DANSON, E.B. 1957. An archaeological survey of west central New Mexico and east central Arizona. Peabody Mus. Arch. and Ethn. 44(1):1-133. Harvard Univ.

HALL, S.A. 1981. Deteriorated pollen grains and interpretation of Quaternary pollen diagrams. Rev. of Paleobot. and Paly. 32:193-206.

HENDRY, G.W. 1931. The adobe brick as a historical source. Agric. History 5:110-127.

__________ and M.P. KELLY. 1925. The plant content of adobe brick. California Hist. Soc. Quar. 4:361-373.

HEVLEY, R.H., P.J. MEHRINGER JR. and H.G. YOCUM. 1965. Modern pollen rain in the Sonoran desert. J. Arizona Acad. Sci. 3:123-135.

JANSSEN, C.R. 1966. Recent pollen spectra from the deciduous and coniferous-deciduous forests of northeastern Minnesota: A study in pollen dispersal. Ecology 47:804-825.

__________. 1967. A comparison between recent regional pollen rain and the sub-recent vegetation in four major vegetation types in Minnesota (USA). Rev. of Paleobot. and Paly. 2:331-342.

JUDD, N.M. 1916. The use of adobe in prehistoric dwellings of the southwest. Pp. 241-252; Holmes Anniversary Volume, (F.W.

LITERATURE CITED (continued)

Hodge ed.), J.W. Bryan Press, Washington, D.C.

KAPP, R.O. 1969. How to Know Pollen and Spores. Wm. C. Brown Co., Dubuque, Iowa. 191 pp.

KELSO, G.K. 1970. Hogup Cave, Utah: Comparative pollen analysis of human coprolites and cave fill. Pp. 251-262 in Hogup Cave, (C.M. Aikens, ed.), Univ. Utah Anthrop. Papers 93.

__________. 1976. Absolute pollen frequencies applied to the interpretation of human activities in northern Arizona. Unpubl. Ph.D. dissert., Univ. Arizona, Tucson, 170 pp.

KING, F.B. 1977. An evaluation of the pollen content of coprolites as environmental indicators. J. Arizona Acad. Sci. 12:47-52.

LEUSCHNER, R.M. and G. BOEHM. 1977. Individual pollen collector for use of hay-fever patients in comparison with the Burkhard trap. Grana 16:183-186.

MAHER, L.J. Jr. 1971. Nomograms for computing 0.95 confidence limits of pollen data. Rev. of Paleobot. and Paly. 13:85-93.

MARTIN, P.S. 1963. The Last 10,000 Years. Univ. Arizona Press, Tucson. 87 pp.

__________ and F.W. SHARROCK. 1964. Pollen analysis of prehistoric feces:A new approach to ethnobotany. Amer. Antiquity 30:168-180.

__________ and C.M. DREW. 1970. Additional scanning electron photomicrographs of southwestern pollen grains. J. Arizona Acad. Sci. 6:140-161.

MEHRINGER, P.J. Jr. 1967. Pollen analysis of Tule Springs, Nevada. Nevada State Mus. Anthrop. Papers 13:130-200.

MONTGOMERY, R.G., W. SMITH and J.O. BREW. 1949. Franciscan Awatovi. Peabody Mus. Amer. Arche. and Ethn., 36:1-336. Harvard Univ.

MORRIS, E.H. 1944. Adobe bricks in a pre-Spanish wall near Aztec, New Mexico. Amer. Antiquity 9:434-438.

O'ROURKE, M.K. 1980. Pollen dispersal and its relationship to respiratory disease. Pp. 81-88 in Proc. 1st Intern'l. Conf. on Aerobiology, Federal Environmental Agency (ed.), Federal Republic of Germany, Erich Schmidt, Berlin.

PECK, R.M. 1973. Pollen budget studies in a small Yorkshire catchment. Pp. 43-68, in, Quaternary Plant Ecology (H.J.B. Birks and R.G. West, eds.). Blackwell, Oxford.

RAYNOR, G.S., E.C. OGDEN and J.V. HAYES 1972. Dispersion and deposition of corn pollen from experimental sources. Agron. J. 64:420-427.

ROGERS, W. 1979. Looking backward to cope with water shorages . . . A history of native plants in southern Arizona. Landscape Archit. 69:304-314.

ROSE, A. 1879. "Glimpse of border life in Arizona." Correspondence with the newspaper Enterprise, Nevada, Ohio, April 17, 1879. Transc. for the Arizona Hist. Soc., Tucson, by Mrs. George Kitt.

SOKAL, R.R. and F.J. ROHLF. 1969. Biometry: The Principles and Practice of Statistics in Biological Research. W.H. Freeman & Co., San Francisco, California. 776 pp.

SOLOMON, A.M. 1979. Sources and characteristics of airborne materials: Factors in the production, release, and viability of biological particles (pollen). In Aerobiology: The Ecological Systems Approach, (R.L. Edmonds ed.). Dowden, Hutchinson and Ross, Inc., Stroudsburg, Pa. 386 pp.

__________ and H.D. HAYES. 1972. Desert pollen production I: Qualitative influence of moisture. J. Arizona Acad. Sci. 7:65-74.

__________. 1980. Impacts of urban development upon allergenic pollen in a desert city. J. Arid Environ. 3:169-178.

STARLING, R.N. and A. CROWDER. 1980. Pollen in the Salmon River system, Ontario, Canada. Rev. of Paleobot. and Paly. 31:311-334.

STOCKMARR, J. 1971. Tablets with spores used in absolute pollen analysis. Pollen et Spores 13:615-621.

TAUBER, H. 1965. Differential pollen dispersion and the interpretation of pollen diagrams. Geol. Survey of Denmark. II Series, No. 89:34-41.

WEBB, J.L. and A.M. SOLOMON. 1974. Human disturbance in arid lands: Pollen evidence of prehistoric land use. Bull. Ecol. Soc. 55:28.

J. Ethnobiol. 3(1):49-54 May 1983

THE ORIGIN AND EVOLUTION OF DOMESTICATED *CAPSICUM* SPECIES

W. HARDY ESHBAUGH
Department of Botany, Miami University,
Oxford, OH 45056

SHELDON I. GUTTMAN
Department of Zoology, Miami University,
Oxford, OH 45056

MICHAEL J. McLEOD
Department of Biology, Belmont Abbey College,
Belmont, NC 28012

ABSTRACT.–Three distinct models, representing an evolution in the thinking on the origin of the domesticated chili peppers *(Capsicum)* are presented in this paper. The first model envisions the origin of the domesticated peppers from a single ancestor, the second suggests that each domesticate had its own distinct ancestral species, while the third sees three separate lines, one of which evolved into *C. annuum, C. frutescens,* and *C. chinense,* a second which gave rise to *C. baccatum,* and a third that led to *C. pubescens.*

INTRODUCTION

The genus *Capsicum* (Solanaceae) includes 4-5 domesticated taxa and more than 20 wild species (Eshbaugh 1980a). Two major questions of interest associated with this important genus of crop plants relate first to its origin and second to the pattern of evolution of the several domesticated taxa.

Any complete understanding of the origin of *Capsicum* depends upon a nonexistent fossil record and, for the present, an inadequate archeological record of the genus. Nonetheless, some conclusions regarding evolution in the genus can be drawn from disparate sources including phytogeographic, isozymic, and karyotypic analyses. The present day geography of the genus suggests that evolution and subsequent radiation took place in several centers including southern Brazil and Bolivia. It is also evident that geographically restricted species, e.g., *C. cardenasii* Heiser & P. Smith from Bolivia, *C. galapogoensis* Hunz. from Ecuador, *C. praetermissum* Heiser & P. Smith from Brazil, etc., arose through founder events that left them isolated from their ancestral gene pool.

DISCUSSION

In a recent, highly speculative paper (McLeod et al. 1982) we advanced the hypothesis that the origin of one segment of the genus is to be found in central Bolivia. Using data from enzyme analysis, and in particular from glutamate oxaloacetate transaminase (GOT), we concluded that a nuclear center for the initial development of that part of the genus which ultimately gave rise to the domesticated taxa occured in an area bounded by Aquile, Comarapa, and Villa Montes, Bolivia. Furthermore, we suggested that subsequent migration and radiation of the ancestral genetic material from this region via the Rio Mizque and associated river systems led to the formation of domesticated *C. pubescens* (Ruis S. Pav.) in highland Bolivia, *C. baccatum* var. *pendulum* (Willd.) Eshb. in lowland Bolivia, and the establishment of another evolutionary line far to the north in the Amazon basin which eventually evolved into the wild types that gave rise to *C. frutescens* L. and *C. chinense* Jacq. Somewhat later in time, *Capsicum* reached Central America and Mexico. Here it evolved further giving rise to a wild type that was finally selected to give domesticated *C. annuum* L. Although *C. annuum* and its presumed wild ancestor represent one of the widest ranging species of peppers there is more certainty about its precise place of origin than with other pepper species. Pickersgill (1971), using karyotypic analysis, established that domesticated *C. annum* probably arose from ancestral material with a unique karyotype found only in plants confined to southern Mexico and Guatemala. Unfortunately, this is as far as we can presently detail a model for the origin of the domesticated taxa of *Capsicum*. The archeological record for the genus is meager and documents only that domesticated *C. baccatum* was established along the coast of Peru by approximately 2000 BC (Pickersgill 1969a). The earliest record of *Capsicum annuum* in Mexico dates back to 7000 BC inferring an ancient domestication. However, the seed size of this material falls within the range of wild seed samples and therefore may only serve to confirm the early exploitation of wild chili peppers rather than prove domestication (Pickersgill, 1969b).

The diverse patterns of evolution that have been proposed for the domesticated chili peppers is of continuing interest. Few of the early workers who described new taxa of *Capsicum* fully appreciated the nature of species in the genus. The naming of taxa led to a great amount of "clerical speciation" with each new fruit type being described as a new taxon. Nineteenth century workers were not aware of the parallel evolution of fruit form from one domesticated taxon to another. Thus, by the mid 1800s we had Dunal (1852) recognizing over 50 species. At another extreme several workers relegated all the peppers to 1-2 species. Irish (1898) reduced the genus to *C. annuum* and its many varieties and *C. frutescens.* Bailey (1923) treated all peppers under the name *C. frutescens,* while Shinners (1956) adopted the same concept but used the name *C. annuum*. Many recent workers still have difficulty distinguishing these taxa and have opted to merge both taxa along with *C. chinense* under a single name (D'Arcy, pers. comm.). Given these difficulties for the nonspecialist, various workers, including Davenport (1970) and Jett (1973), have adopted an evolutionary model (Fig. 1A) that argues that all the domesticated taxa have arisen from the single species *C. frutescens.* This model opposes the idea of multiple independent centers and sources of domestication in Middle and South America. This is a neat model and fits nicely the dogma which argues that within a small group of plants from a relatively restricted geographic area, e.g., the New World tropics, it is unlikely that the events leading to domestication would arise more than once. Nonetheless, the evidence from morphology, plant breeding, and enzyme analysis supports the argument of at least three domesticated taxa (Smith and Heiser 1951, 1957; Eshbaugh 1970, 1975, 1979; Pickersgill 1971, 1980; Pickersgill et al. 1979; McLeod et al. 1979a, 1979b, In Press).

The distinctness of these taxa has been detailed by Heiser et al. (1971), and at the same time they proposed a model of independent centers of domestication for *Capsicum* in the Americas. The natural extension of that model envisions four and perhaps five distinct evolutionary lines leading to the domesticates (Fig. 1B). In this model each domesticated taxon has a companion wild ancestral form that it was selected from. A five species model would require that *C. frutescens* be treated as a true domesticate and that a wild progenitor be designated for both *C. chinense* and *C. frutenscens.* These ancestors might be primitive forms of the same taxon such as those proposed for *C. annuum* and *C. baccatum,* distinct species as indicated for *C. pubescens,* or extinct taxa no longer on the scene. The multiple independent origins model addresses the known data for the genus in a more realistic fashion than does the single species model. However, studies of the past four years suggest a refinement of this earlier model (Fig. 1C).

Pickersgill et al. (1979) made a detailed morphological analysis of *C. annuum, C. frutescens, C. chinense,* and *C. baccatum,* that confirms the separateness of *C. baccatum* from the other three taxa, and proposed that it was most likely derived from wild forms of the same species as had been suggested earlier by Smith and Heiser (1957) and Eshbaugh (1970). Furthermore, their studies indicated that at the domesticated level there are three distinct groups and "a poorly defined complex of wild forms." McLeod et al. (1979a, 1979b, In Press), analyzed the same taxa but also included *C. pubescens* in their allozymic investigation of variation in the genus. This study indicated three separate

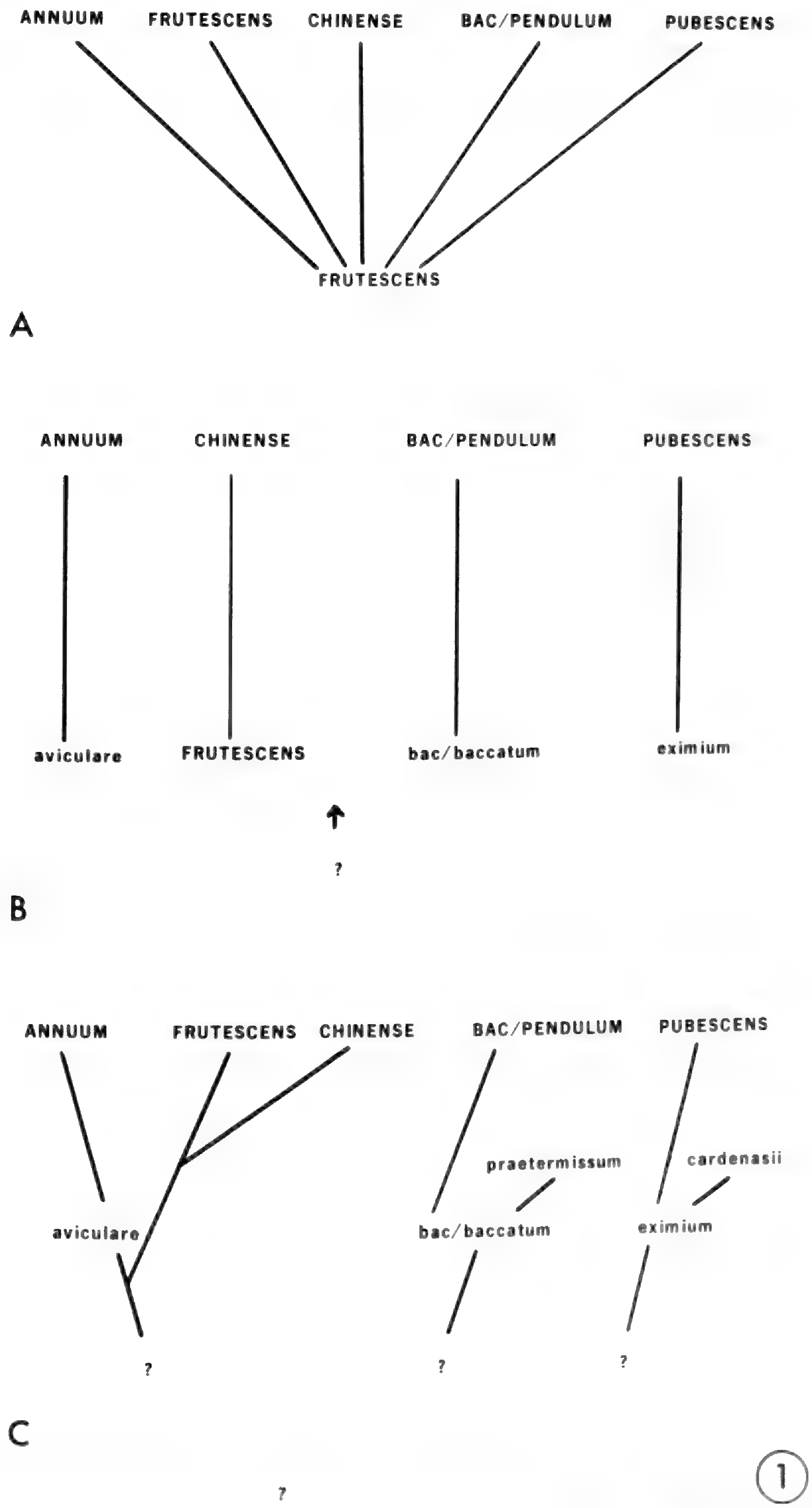


FIG. 1.–Models of speciation in *Capsicum:* A – monophyletic origin of domesticated taxa from a single ancestor. B – multiple origin of domesticated taxa each from a distinct progenitor, and C – three independent lines of origin of domesticated taxa from unknown ancestors. Domesticated taxa in upper case type and wild taxa in lower case type. Eshbaugh 1980b.

taxa, *C. baccatum, C. pubescens,* and a complex of *C. annuum, C. frutescens,* and *C. chinense.* Allozyme data support the idea of a poorly differentiated complex of wild forms and extend this concept to the domesticated taxa. When all the allozyme data are subjected to numerical treatment using Principal Coordinates Analysis (Jensen et al. 1979) a picture emerges that can be incorporated with both morphological and plant breeding information to give a revised version of the model (Fig. 2). This model takes into account our current knowledge and envisions a common ancestral gene pool that gave rise to three well defined and distinct evolutionary lines. One of these lines developed into what we now recognize as the domesticated species complex *C. chinense, C. frutescens,* and *C. annuum.* At a more primitive level one cannot distinguish between the three species. As Pickersgill et al. (1979) have noted, this anomalous situation has led to our current taxonomic difficulty with this complex. On the one hand we treat the three domesticated taxa as separate while the corresponding wild forms intergrade to such an extent that it is impractical if not impossible to give them distinct taxonomic names. The closer relationship of *C. chinense* and *C. frutescens* is also recognized by this model as well as the separate pathway of *C. annuum,* which, although closely allied to *C. frutescens* and *C. chinense,* branched off at an earlier time. A second evolutionary line has *C. baccatum* var. *pendulum* evolving from wild material of the same gene pool. It also indicates that *C. praetermissum* evolved from the same complex but is not directly linked to the evolution of the domesticate. The geographically restricted *C. praetermissum* seems to be a more likely example of speciation from a founder event in southern Brazil outside the main distribution of *C. baccatum.* A third evolutionary line has *C. pubescens* arising

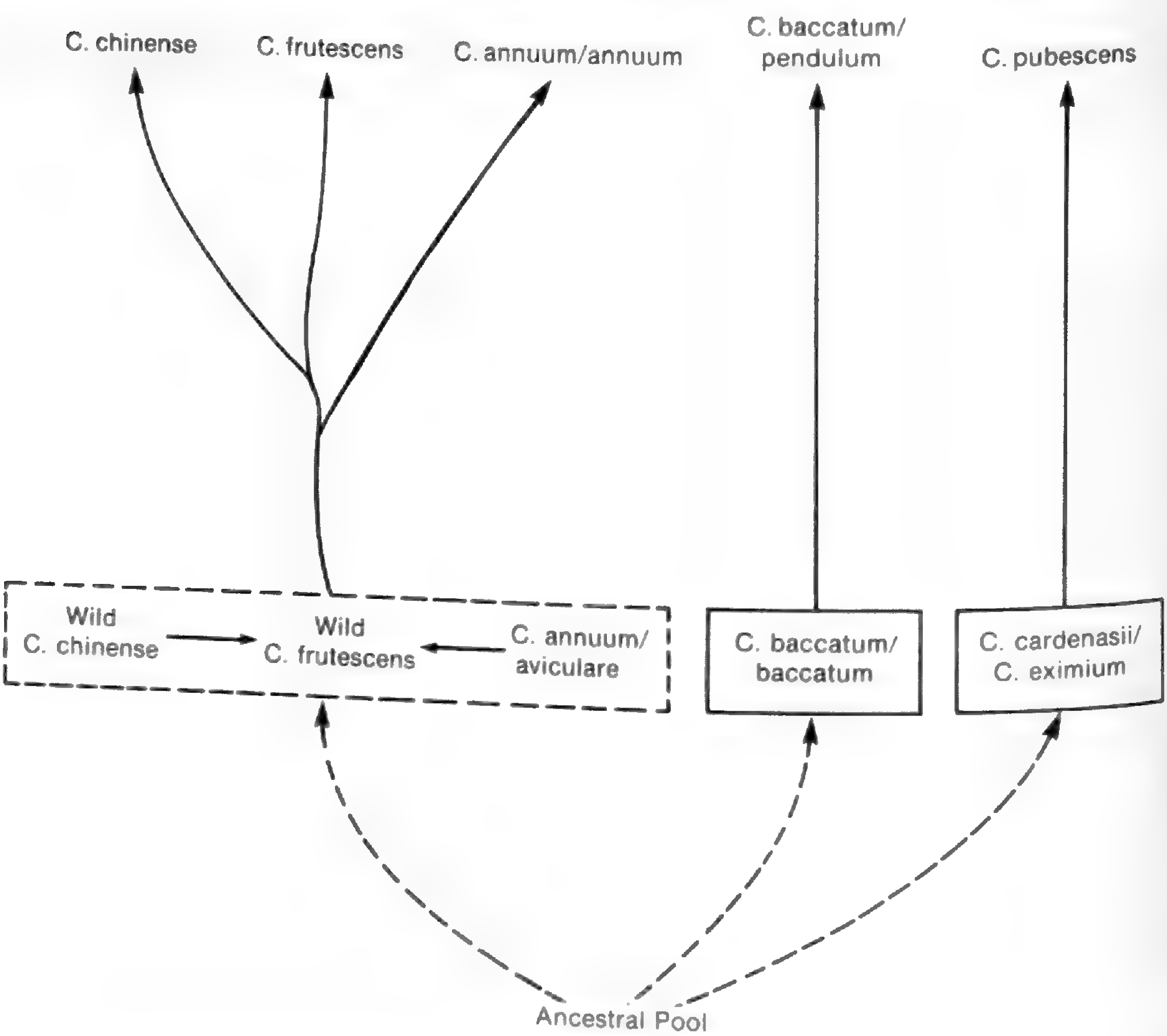


FIG. 2.—A synthetic model depicting the evolution of the domesticated taxa of *Capsicum* (Solanaceae).

from *C. eximium* Hunz. with *C. cardenasii* representing a narrow endemic which probably arose from another founder event. *Capsicum eximium* is very closely linked genetically to *C. pubescens.* Pickersgill (pers. comm.) has argued that the evidence for this species as the ancestor of *C. pubescens* is tenuous at best. However, the question of the role of *C. eximium* in the evolution of *C. pubescens* has no effect on the proposed model of evolution as far as recognizing three distinct paths to the domesticated taxa is concerned.

At the outset of this discussion we developed a hypothesis regarding a site for early evolution of the genus. The proposed model of evolution for the domesticated taxa (Fig. 2) is entirely compatible with this hypothesis.

ACKNOWLEDGEMENTS

Various parts of the work which led to the development of this paper were supported by the following agencies. NSF (GB-31932, DEB 76-11478, and DEB 78-23389), Sigma Xi, the National Geographic Society (Grants No. 901 and 1025), the American Philosophical Society (Penrose Fund), the Explorers Club, and various offices of Miami University. This paper was originally presented at the 13th International Botanical Congress, Sydney, Australia in 1981.

LITERATURE CITED

BAILEY, L. H., 1923. *Capsicum*. Gentes Herb. 1:128-129.

DAVENPORT, W.A., 1970. Progress report on the domestication of *Capsicum* (Chili Peppers). Proc., Assoc. Amer. Geogr. 2:46-47.

DUNAL, M. F. 1852. Solanaceae. *In*, Prodromus systematis naturalis regni vegetabilis. 13(1):1-690.

ESHBAUGH, W. H. 1970. A biosystematic and evolutionary study of *Capsicum baccatum* (Solanaceae). Brittonia 22:31-43.

ESHBAUGH, W. H. 1975. Genetic and biochemical systematic studies of chili peppers *(Capsicum* – Solanaceae). Bull. Torrey Bot. Club 102:396-403.

ESHBAUGH, W. H. 1979. A biosystematic and evolutionary study of the *Capsicum pubescens* complex. Natl. Geogr. Soc. Res. Rep., 1970, Projects:143-162.

ESHBAUGH, W. H. 1980a. The Taxonomy of the Genus *Capsicum* (Solanaceae) – 1980. Phytologia 47:153-166.

ESHBAUGH, W. H. 1980b. Models of speciation in the genus *Capsicum* (Solanaceae). Abstract. 2nd International Congress of Syst. and Evol. Biology, Vancouver, p. 192.

HEISER, C. B., JR., W. H. ESHBAUGH, and B. PICKERSGILL. 1971. The domestication of *Capsicum* – A reply to Davenport. Prof. Geogr. 23:169-170.

IRISH, H. C. 1898. A revision of the genus *Capsicum* with especial reference to garden varieties. Missouri Bot. Gard., 9th Annu. Rep.:53-110.

JENSEN, R. J., M. J. McLEOD, W. H ESHBAUGH, and S. I. GUTTMAN. 1979. Numerical taxonomic analyses of allozymic variation in *Capsicum* (Solanaceae). Taxon 28:315-327.

JETT, S. C. 1973. Comment of Pickersgill's "Cultivated plants as evidence for cultural contacts." Amer. Antiquity 38:223-225.

McLEOD, M. J., W. H. ESHBAUGH, and S. I. GUTTMAN. 1979a. A preliminary biochemical systematic study of the genus *Capsicum* – Solanaceae. Pp. 701-713 *in,* The Biology and Taxonomy of the Solanaceae (J. G. Hawkes, R. N. Lester, and A. D. Skelding, eds.). Acad. Press, New York.

McLEOD, M. J., W. H. ESHBAUGH, and S. I. GUTTMAN. 1979b. An electrophoretic study of *Capsicum* (Solanaceae): The purple flowered taxa. Bull. Torrey Bot. Club 106: 626-633.

McLEOD, M. J., S. I. GUTTMAN, and W. H. ESHBAUGH. 1982. Early evolution of chili peppers *(Capsicum).* Econ. Botany 35:361-368.

McLEOD, M. J., S. I. GUTTAMN, W. H. ESHBAUGH, and R. E. RAYLE. In Press. An electrophoretic study of evolution in *Capsicum* (Solanaceae). Evolution.

PICKERSGILL, B. 1969a. The archaeological record of chili peppers *(Capsicum* spp.) and the sequence of plant domestication in Peru. Amer. Antiquity 34:54-61.

PICKERSGILL, B. 1969b. The domestication of chili peppers. Pp. 433-450 *in,* The domestication and exploitation of plants and animals. (P. J. Ucko and G. W. Dimbleby, eds.), Gerald Duckworth & Co., Ltd., London.

PICKERSGILL, B. 1971. Relationships between weedy and cultivated forms in some

LITERATURE CITED (continued)

species of chili peppers (genus *Capsicum).* Evolution 25:683-691.

PICKERSGILL, B. 1980. Some aspects of interspecific hybridisation in *Capsicum.* Unpubl. and preliminary report presented at the IVth EUCARPIA *Capsicum* working group meetings in Wageningen, The Netherlands.

PICKERSGILL, B., C. B. HEISER, JR., and J. McNEILL. 1979. Numerical taxonomic studies on variation and domestication in some species of *Capsicum.* Pp. 679-700 *in,* The Biology and Taxonomy of the Solanaceae (J. G. Hawkes, R. N. Lester, and A. D. Skelding, eds.), Acad. Press, New York.

SHINNERS, L. H. 1956. Technical names for the cultivated *Capsicum* peppers. Baileya 4: 81-83.

SMITH, P. G., and C. B. HEISER, JR. 1951. Taxonomic and genetic studies in the cultivated peppers, *Capsicum annuum* L. and *C. frutescens* L. Amer. J. Botany 38:362-368.

SMITH, P. G., and C. B. HEISER, JR.. 1957. Breeding behavior of cultivated peppers. Proc. Amer. Soc. Hort. Sci. 70:286-290.

Book Review

Etnobotanica en el Estado de Morelos. Bernardo Baytelman. Instituto Nacional de Antropologia e Historia. Mexico, D.F. (no publication date) 287 pp. illus. 220 pesos (paperback).

Bernardo Baytelman has integrated data from the early Spanish chroniclers Bernardino de Sahagun, Martin de la Cruz, Juan Badiano, and Francisco Hernandez with contemporary information on the use of medicinal herbs in the northern part of the State of Morelos in Mexico. In a style characteristic of recent scientific work in Mexico, Baytelman included an explicit and detailed research design in this monograph along with five questionnaires that he used in his interviews. These should stand as models for other investigators doing research on medicinal plants. He also included detailed interviews with three herbalists from Tepoztlan, Oaxtepec, and Cuernavaca. Supplemental information was collected from herb vendors in the market at Cuernavaca.

This volume contains detailed information on fifty medicinal plants, arranged by local common name, cross-referenced with the early Spanish herbals, and illustrated with drawings from the Hernandez' *Obras Completas.* Additional data is presented on 173 species along with methods of preparation and administration, something often lacking in works on medicinal plants. Finally all plants are cross-indexed according to the part of the body and diseases they are used to treat.

In a nation with thirty million people living in rural areas, herbal medicine is still an important part of primary health care. Baytelman has provided an interesting and useful summary of a medical system than began in the Prehispanic era, was modified by an influx of European ideas, and has flourished into the Twentieth Century.

CHM

J. Ethnobiol. 3(1):55-62 May 1983

PUFFBALL USAGES AMONG NORTH AMERICAN INDIANS

WILLIAM R. BURK
301 Coker Hall 010-A, University of North Carolina
Chapel Hill, NC 27514

ABSTRACT.—This paper reviews the literature on the usages of puffballs (Lycoperdales and Tulostomatales) among the North American Indians. Usages are discussed under six general categories: religious, aesthetic/decorative, hemostatic, other medical uses, paramedical possibilities, and dietary or food uses. A table summarizing these usages of puffballs is provided.

INTRODUCTION

The importance of ethnomycological investigations is beginning to be appreciated even outside the narrower circle of mycologists. What little is known about usage and cultural significance of a number of fungi, including the puffballs (Lycoperdales and Tulostomatales) is scattered throughout the literature. This paper presents a literature review of the uses of puffballs by the North American Indians. Of the 102 ethnographies reviewed 50 included coverage of the fungi, with 36 of this latter group mentioning the puffballs. Although many North American Indian groups used puffballs for food, medicine, or other functions (Table 1), the Yuki (Chestnut 1974) and the British Columbia Indians (Turner 1978) avoided the puffballs, but yet used other fungi of their regions as an article of food.

In a literature review article it is not possible to verify identifications of the species mentioned. Puffballs are distinctive in appearance, yet immature mushrooms, particularly the *Amanita* species, can be mistaken for a puffball. Puffballs are quite common throughout the North American region and occur throughout the growing season. Some species, though, are limited to particular habitats, such as the stalked puffballs, *Battarrea* and *Tulostoma*, which are found in arid regions or in sandy soil.

DISCUSSION

The focus of this paper is on usages of puffballs by North American Indians. Usages fall logically into six general categories: (1) Religious/Magical; (2) Aesthetic/Decorative; (3) Hemostatic; (4) Other Medical Uses; (5) Paramedical Possibilities; and (6) Dietary or Food Uses.

Religious/Magical Uses.—Puffballs, which typically grew in circles on the prairies, were called by the Blackfoot *ka-ka-toos* or "fallen stars." According to Indian legend, puffballs were stars fallen to earth during supernatural events (Hellson 1974). Puffballs and other fungi likewise were used as incense by these Indians in order to keep away ghosts. Chestnut (1974) reported that an Indian medicine man used dried puffballs, each filled with pieces of gravel and tied to a stick for a rattle. Another ploy was to decorate the tipi cover with figures of puffballs. Through a kind of sympathetic magic (since puffballs were commonly used as tinder or punk for lighting fires), the Blackfoot painted a small circle of puffballs at the base of their tipis, the representations of which were to insure fire to those within. Fire was a necessary ingredient for the survival of life. Johnston (1972), in fact, believes that these circular objects (puffballs) represent life itself arising out of the sacred earth.

Aesthetic/Decorative Uses.—Related to the tipi decoration function is the common use of puffballs as items of personal adornment or for aesthetic enjoyment. These usages often took on religious/magical meaning as well. The Chippewa Indians used the puffball, *Bovista pila* B. & C., as a magical charm (Densmore 1928). Wissler (cited in Johnston

TABLE 1.—*Summary of Puffball Usages Among North American Indians.*

Indian Group	Fungus	Use(s)	Reference
Ahnishinaubeg	Puffballs	Food; smoking out bees	Keewaydinoquay 1978
	Calvatia utriformis (Bull. ex Pers.) Jaap [cited as *Lycoperdon caelatum*]	Hemostat	
Arikara	Puffballs	Poultice ingredient for breast inflammation & abscess	Gilmore 1931
Blackfoot	Lycoperdon spp.	Punk; tipi decoration; incense to ward off ghosts; hemostat	Hellson 1974
Central Miwok	*Calvatia sculpta* (Harkness) Lloyd [cited as *Lycoperdon sculptum*]	Food	Barrett and Gifford 1933
Cherokee	*Lycoperdon perlatum* Pers. ex Pers.; *L. pyriforme* Schaeff. ex Pers.	Healing agent for sores	Hamel and Chiltoskey 1975
	Geastrum [cited as *Geaster*]	Prophylactic and therapeutic use on navel of newborn infants	Mooney and Olbrechts 1932
Chippewa	*Bovista pila* B. & C.; *Calvatia craniiformis* (Schw.) Fr.	Charm; hemostat	Densmore 1928
Iroquois	Puffballs	Food, especially in soups	Parker 1910
	Calvatia gigantea (Batsch ex. Pers.) C.G. Lloyd [cited as *Lycoperdon sculptum*]; *Lycoperdon* sp.	Food	Waugh 1916
Kiowa	*Lycoperdon* spp.	Food; hemostat	Vestal and Schultes 1939

TABLE 1.—*Summary of Puffball Usages Among North American Indians.* (continued)

Indian Group	Fungus	Use(s)	Reference
Kwakiutl	Puffball spores	Hemostat	Boas 1932
Makah	*Calvatia cyathiformis* (Bosc) Morg. [cited as *C. lilacina*]	Medicine	Densmore 1939
Menomini	*Lycoperdon pyriforme* Schaeff. ex Pers.	Dusting powder	Smith 1923
	Puffballs	Food	
Meskwaki	*Calvatia gigantea* (Batsch ex Pers.) C.G. Lloyd	Food (introduced by H.H. Smith)	Smith 1928
Missouri River region Indians: (Pawnee, Ponca, Omaha, Dakota)	*Lycoperdon perlatum* Pers. ex Pers. [cited as *L. gemmatum*]; *Calvatia cyathiformis* (Bosc) Morg.; *Bovista plumbea* Pers. ex Pers.	Hemostat	Gilmore 1977
Mohegan	Puffballs	Hemostat	Tantaquidgeon 1928
Navajo	Puffballs	Hemostat; poultice; infusion for sores, burns, itches	Wyman and Harris 1941
Ojibwe	*Calvatia craniiformis* (Schw.) Fr.	Hemostat for nosebleeds	Smith 1932
Omaha		Food	Gilmore 1977
Paiute (of Nevada)	*Battarea phalloides* (Dicks.) Pers.	Poultice for swellings and sores	Train et al. 1941
Potawatomi	*Morganella subincarnata* (Peck) Kreisel & Dring [cited as *Lycoperdon subincarnatum*]	Headache cure; dusting powder	Smith 1933

TABLE 1.—*Summary of Puffball Usages Among North American Indians.* (continued)

Indian Group	Fungus	Use(s)	Reference
Ramah Navaho	*Tulostoma campestre* Morg.; *T. brumale* Pers. ex Pers. [cited as *T. pedunculatum* L.]	Poultice or infusion for healing sheep leg-bone fractures	Vestal 1952
Tewa	Puffballs	Food	Robbins et al. 1916
	Geastrum sp. [cited as *Geaster]*	Medicine	
Yuki	*Lycoperdon* sp.	Healing agent for sores; rattle for medicine man	Chestnut 1974
Zuñi	*Lycoperdon* sp.	Food	Stevenson 1915

1972) mentions the fact that some Blackfoot men wore necklaces of puffballs about the size of tennis balls and strung together on a thong. Such necklaces were prized because of the delicate odor they gave off. Indian boys sometimes wore a bandolier of puffballs across the chest, not strictly for aesthetic reasons, but primarily as a means of warding off respiratory diseases (Dempsey, cited in Johnston 1972). Not all North American Indians treated the puffballs quite so reverently. A commonly mentioned use of the puffball was in children's games. Children would gather the mature puffballs to play make-believe volcanoes ("puffs" of smoke from the "craters") (Curtin 1974).

Although apparently not a North American Indian usage, Watling & Seaward (1976) pointed out that prehistoric puffballs, *Bovista nigrescens* Pers. ex Pers. and *Calvatia utriformis* (Bull. ex Pers.) Jaap, may have been used more practically as insulation material to stop up holes in drafty dwellings.

Hemostatic Uses.—One of the major medical uses of puffballs by the North American Indians was as a styptic. The soft, central portion of dried, immature puffballs was pulverized and dusted into the broken skin or wound to stop bleeding. *Lycoperdon perlatum* Pers. ex Pers. (cited as *L. gemmatum* Batsch) was employed as a hemostatic agent by the American Indian (Corlett 1935). The Rocky Mountain Indians used the "prairie mushroom" to heal the navels of newborn infants (Scully 1970). *Geastrum* was used during parturition by the Cherokee (Mooney & Olbrechts 1932). The Missouri River region Indians likewise used puffball spores. From its universal application to this use among the Dakota is derived their name for the puffball, *Hokshi chekpa,* or "baby's navel" (Gilmore 1977).

The styptic function of puffballs (as aids in parturition or simply as cauterization for castration wounds, cuts or internal hemorrhages) is well documented both geographically and throughout history. This usage is, of course, not confined to North American Indians. Surgeons in the nineteenth century in Europe used puffball powder as a hemostat and the same remedy was employed in this century by the Pennsylvania Germans (Vogel 1970). A string of puffballs hung by the fireplace in many farm houses in cases of emergency (Watling and Seaward 1976).

Nonetheless, the use of puffballs as a hemostatic agent was practically universal among American Indians. The Navajo used the dried spores of members of the Lycoperdales as dusting powders, poultices and even lotions (Wyman and Harris 1941). Keewaydinoquay (1978) related that *C. utriformis* (cited as *Lycoperdon caelatum*) was favored by the Ahnishinaubeg medicine woman, Nodjimahkwe, as a coagulant for heavy bleeding. The spores were blown onto the open wound. By combining puffball spores and spiderwebs held onto the skin by criss-crossing strips of bark from *Prunus emarginata* v. *villosa* Sudw. and securing the dressing with gum, the Kwakiutls in Canada were able to stop bleeding on the surface of the skin (Boas 1932). The Mohegans also used spiderwebs and puffball spores as a hemostatic dressing (Tantaquidgeon 1928). The Blackfood drank a spore infusion for the treatment of internal hemorrhages. They also used species of *Lycoperdon* as a hemostat for castration wounds, cuts and nose bleeds (Hellson 1974). Likewise, the Chippewa (Densmore 1928) and the Ojibwe (Smith 1932) used the giant puffball, *Calvatia craniiformis* (Schw.) Fr. to halt nose bleeds. The Ojibwe would snuff the dried capillitia and spores up the nose. This remedy was a common Indian practice. Both the Rappagannock and the Mohegans used the powder of puffballs to stop bleeding, but the Rappahannock believed the powder was dangerous to inhale and termed it, appropriately, the "devil's snuff" (Weslager 1973).

Today it is medically recognized that massive inhalation of the spores of puffballs can cause symptoms of the reactive, pulmonary disease termed lycoperdonosis (Strand et al. 1967 and Henriksen 1976). This disease is characterized by pneumonia-like symptoms.

The Yuki of California believed puffball spores would cause blindness if allowed to get in the eyes (Curtin 1957). The Ramah Navajo used the name "no eyes" for *Geastrum* and *Tulostoma* since they feared that spores of these puffballs would cause blindness (Vestal 1952). It is easy to see why some Indians looked upon this so-called "devil's snuffbox" with superstition and fear.

Other Medical Uses.—Literature records other medical uses of puffballs. The Kiowa moistened the dry spores and applied them to small sores and scratches (Vestal and Schultes 1939). The Arikara made a poultice from the spore mass of a puffball, mixed with the pulverized roots of the red baneberry, *Actea rubra* (Ait.) Willd., to give prompt relief from inflammation and abscess of the breast of mothers (Gilmore 1931). The use of the dry spores of members of the Lycoperdales was widespread among the Navajo (Wyman and Harris 1941). Prescriptions for sores were used in cases of burns or itching. A cold infusion or poultice of the mycelium of *Tulostoma campestre* Morg. or *T. brumale* Pers. ex Pers. (cited as *T. pedunculatum* L.) was even used by the Ramah Navaho in veterinary exercises to heal sheep leg-bone fracture (Vestal 1952).

Young puffballs were generally gathered, sliced, and used as a dressing for swellings and sores. The powder of the mature puffball was often used as a remedy for earaches and broken eardrums (Scully 1970). The Tewa blew the spores of *Geastrum* (meaning "earth swelling") into the ear through a tube of corn husk to clear up discharges from the ear (Robbins, Harrington and Freire-Marreco 1916). Various species of *Lycoperdon* were used by the Blackfoot for removing foreign objects from the eyes (Johnston 1972). The dried interior of the immature puffball was held on the eye to remove the foreign object. Puffball uses were not, however, confined to therapeutic practices. The Menomini believed that the smoke-like powder discharged from the mature puffball, *Lycoperdon pyriforme* Schaeff. ex Pers., could cause permanent blindness to an approaching enemy (Smith 1923).

For a headache cure the Potawatomi used the pinkish puffball, *Morganella subincarnata* (Peck) Kreisel & Dring (cited as *Lycoperdon subincarnatum* Pk.), which they appropriately called "the headache berry" (Smith 1933). How the dose was given is not known. The spores of the same species and of *L. pyriforme* were used by the Potawatomi (Smith 1933) and Menomini (Smith 1923), respectively, for soothing chafing between the legs and under the arms of infants. Besides being readily available and effective, this "Indian baby talcum" was eminently the proper shade to use (Smith 1923).

Slightly more controversial uses of puffballs include the following: Hooker (cited in Watling and Seaward 1976) related that in the Far East puffballs were burnt on the skin as a cautery or counter-irritant for gout. This apparently was never an American Indian practice. A much more spectacular discovery is the recent association between certain puffballs and reduction of cancers. Beneke (1963) has produced some scientific support for an ancient folk belief that some species of puffballs act as anti-tumor agents. In laboratory situations, Beneke found that *Calvatia* species produce chemical substances active against tumors. Again, there is no mention of this particular usage among the North American Indians. Gasco et al. (1974) have reported that an antibacterial and antifungal agent has been isolated from *C. cyathiformis* (Bosc) Morg. (cited as *C. lilacina).* One year later Umezawa, et al. (1975) independently reported the antibiotic and antitumor isolate, which they named calvatic acid, from another puffball, *C. craniiformis* (Schw.) Fr.

Paramedical Possibilities.–Some other uses of puffballs are worth a brief review. Among the Ahnishinaubeg there is mention of the anesthetizing effects of the burning puffball when employed by the Indians to smoke out bees (Keewaydinoquay 1978). This was a common practice throughout North America. The literature is speculative in discussing the possible uses of puffballs as hallucinogenic agents. *Scleroderma verrucosum* Bull. ex Pers. is reported to cause gastrointestinal intoxication and *Lycoperdon pedicellatum* Peck (cited as *L. candidum), L. mixtecorum* Heim and *L. qudenii* Bottom. (cited as *Vascellum qudenii* [Bottom.] Ponce de Leon) are apparently questionable hallucinogenic intoxicants (Ott, Guzman, Romano and Diaz 1975). Lincoff and Mitchel (1977) stated that *L. marginatum* Vitt. ex Moris et De Not. is reported to produce psychoactive effects.

Dietary or Food Uses.–Culinary aspects of puffball usage are seemingly contradictory. Chestnut (1974) writes that the Indians of Mendocino County, California, disclaimed "any knowledge of the really edible qualities of puffballs;" in fact, they looked upon them with grave superstition. The Iroquois referred to the puffball as "devil's bread" (Waugh 1916). Certainly the Indians of British Columbia regarded them with apprehension, as evidenced by some of their names for puffballs, among them: "ghost's make-up," "ground ghost," and even "corpse." Mushrooms of any kind were avoided by the Kootenay people and given the unlikely name of "frog's navel" in the native language. It is further reported that the puffballs were not generally eaten by the Athapaskan people of Central and Northern British Columbia, although one source does suggest that the Slave ate them in times of famine (Turner 1978).

It is well to remember that puffballs must be eaten only when white and young, and they should be cut in half in order to be sure that an immature *Amanita* is not collected. Some species, e.g., *M. subincarnata* (cited as *Lycoperdon subincarnatum),* and *Scleroderma citrinum* Pers. and *S. cepa* Pers. have been reported or suspected as poisonous to eat (Lincoff and Mitchel 1977). Nevertheless, among the different groups of fungi, the puffballs are probably one of the safest groups to collect for food. Many species have been sought after as culinary delicacies throughout the world.

Tewa informants stated that they ate all kinds of fungi and puffballs without suffering any ill effects (Robbins et al. 1916). While white and firm, before the spores formed, puffballs were roasted for food by the Omaha (Gilmore 1977), and the Zuñi gathered puffballs in large quantities in the fresh state for food, and also dried them for consumption during the winter months (Stevenson 1915). The Iroquois liked the edible fungi quite as well as meat and esteemed puffballs as good material for soup. The fungi were peeled, diced, and then boiled in water with salt, grease and bits of meat as seasoning to make a tasty puffball soup. Puffballs were also fried in sunflower oil, bear oil or deer tallow (Parker 1910). It especially appealed to the Indians that these fungi might be used in soups, for soup was a favored dish with aborigines (Smith 1928). The Central Miwok used *Calvatia sculpta* (Harkness) C.G. Lloyd (cited as *Lycoperdon sculptum* [Harkness]), which they ground, boiled, and ate with acorn soup (Barrett and Gifford 1933). Other puffballs were eaten either raw or cooked. Keewaydinoquay (1978) reported that the Ahnishinaubeg enjoyed meals with puffballs. It was stressed, however, that the delicate taste of the puffball would be lost if salt were added before the cooking was completed.

Little is known about the true nutritive value of edible mushrooms, including puffballs. The nutrient composition of *C. cyathiformis* (cited as *C. lilacina)* is reported by Crisan and Sands (1978). *Lycoperdon perlatum* (cited as *L. gemmatum)* has a relatively low ascorbic acid content (Gilbert & Robinson 1957). Mushrooms appear to be good sources of several vitamins and minerals. Puffballs, however, have no significant vitamins, but considerable amounts of calcium, phosphorus, iron, sodium, and potassium. Mushrooms may be principally a carbohydrate source. Although impossible to make general statements which are true of all mushrooms, at their best some mushrooms provide nutritive value comparable to some high protein foods. The nutritional contribution to the diet is likely to correlate with the degree that the food is used as a staple (Crisan and Sands 1978). The nutritional assessment of species of puffballs, however, is needed.

CONCLUSIONS

Although some usages of puffballs, such as the styptic function, are well known, other lesser functions of this interesting group of fungi are not as well appreciated. Investigations into the medical, paramedical and nutritional uses of the puffballs need to be encouraged in the future. Moreover, our fuller appreciation of the cultural backgrounds of Indian usages of these fungi can be enhanced by further ethnomycological studies.

ACKNOWLEDGEMENTS

The author extends sincere gratitude to Richard E. Rex for supplying several references; to Dr. Vincent Demoulin for providing nomenclatural guidance for the species of puffballs; to Dr. Clark T. Rogerson for reviewing the manuscript; and to Karen Hildebrandt for typing the manuscript text and table. Special thanks are given to Dr. Tom K. Fitzgerald for ideas and input on this paper which has previously been published in an abridged and popularized version in McIlvainea 5:14-17, 1981, by W. R. Burk and T. K. Fitzgerald.

LITERATURE CITED

BARRETT, S. A. and E. W. GIFFORD. 1933. Miwok material culture. Bull. Pub. Mus. Milwaukee 2(4):[117]-403.

BENEKE, E. S. 1963. *Calvatia,* calvacin and cancer. Mycologia 55:257-270.

BOAS, F. 1932. Current beliefs of the Kwakiutl Indians. J. Amer. Folk-lore 45(176): [177]-260.

CHESTNUT [i.e. Chesnut], V. K. 1974. Plants used by the Indians of Mendocino County, California. Reprinted by Mendocino County Hist. Soc. as first published in Contr. U.S. Natl. Herb., Vol. VII. 295-423. Fort Bragg, Calif., Mendocino County Hist. Soc., 1974.

CORLETT, W. T. 1935. The medicine-man of the American Indian and his cultural background. Springfield, Illinois, C. C. Thomas. 369 pp.

CRISAN, E. V. and A. SANDS. 1978. Nutritional value pp. 137-168. The Biology and Cultivation of Edible Mushrooms in, (S. T. Chang and W. A. Hayes, eds.). New York, Acad. Press. 819 pp.

CURTIN, L. S. M. 1957. Some plants used by the Yuki Indians of Round Valley, Northern California. (Part II). Masterkey 31:85-94.

__________. 1974. Healing herbs of the Upper Rio Grande. Southwest Museum, Los Angeles. 281 pp.

DENSMORE, F. 1928. Uses of plants by the Chippewa Indians. Annu. Rep. Bur. Amer. Ethn. 44:275-397.

__________. 1939. Nootka and Quileute music. Bur. Amer. Ethn. Bull. 124:1-358.

GASCO, A., A. SERAFINO, V. MORTARINI, E. MENZIANI, M.A. BIANCO and J. C. SCURTI. 1974. An antibacterial and antifungal compound from Calvatia lilacina. Tetrahedron Lett. 1974(38):3431-3432.

GILBERT, F.A. and R.F. ROBINSON. 1957. Food from fungi. Econ. Botany 11:126-145.

GILMORE, M.R. 1931. Notes on gynecology and obstetrics of the Arikara tribe of Indians. Pap. Michigan Acad. Sci., Arts and Letters 14:71-81.

__________. 1977. Uses of plants by the Indians of the Missouri River region. Reprinted from the Thirty-third Annual Report of the Bur. Amer. Ethn., 1919. Lincoln, Univ. Nebraska Press. 109 pp.

HAMEL, P. B. & M. U. CHILTOSKEY. 1975. Cherokee Plants and Their Uses—A 400 Year

LITERATURE CITED (continued)

History. Herald Publ. Co., Sylva, North Carolina. 65 pp.

HELLSON, J. C. 1974. Ethnobotany of the Blackfoot Indians. (Canadian Ethn. Ser. paper, 19). National Museums of Canada, Ottawa. 138 pp.

HENRIKSEN, N.T. 1976. Lycoperdonosis. Acta Paediatr. Scand. 65:643-645.

JOHNSTON, A. 1972. Man's utilization of the flora of the Northwest Plains. Post-Pleistocene Man and His Environment on the Northern Plains. In, (R. G. Forbis et al., eds.) Students' Press, Calgary, Alta. 220 pp.

KEEWAYDINOQUAY. [Keewaydinoquay M. Pakawakuk Peschel]. 1978. Puhpohwee for the people; a narrative account of some uses of fungi among the Ahnishinaubeg. (Ethnomycological studies, no. 5). Cambridge, Mass., Botanical Mus. Harvard Univ., distributed by Ross-Erikson, Santa Barbara, Calif. 44 pp.

LINCOFF, G. and D. H. MITCHEL. 1977. Toxic and Hallucinogenic Mushroom Poisoning; A Handbook for Physicians and Mushroom Hunters. Van Nostrand Reinhold Co., New York. 267 pp.

MOONEY, J. (Revised, completed and edited by F. M. Olbrechts). 1932. The Swimmer manuscript, Cherokee sacred formulas and medicinal prescriptions. Bur. Amer. Ethn. Bull. 99:1-319.

OTT, J., G. GUZMAN, J. ROMANO and J. LUIS DIAZ. 1975. Nuevos datos sobre los supuestos Licoperdaceos psicotropicos y dos casos de intoxicacion provocados por hongos del genero *Scleroderma* en México. Bol. Soc. Méx. Mic. 9:67-76.

PARKER, A. C. 1910. Iroquois uses of maize and other food plants. New York State Mus., Mus. Bull. 144:1-119.

ROBBINS, W. W., J. P. HARRINGTON and B. FREIRE-MARRECO. 1916. Ethnobotany of the Tewa Indians. Bur. Amer. Ethn. Bull. 55:1-124.

SCULLY, V. 1970. A Treasury of American Indian Herbs; Their Lore and Their Use for Food, Drugs and Medicine. Bonanza Books, New York. 306 pp.

SMITH, H. H. 1923. Ethnobotany of the Menomini Indians. Bull. Public Mus. Milwaukee 4(1):[1]-174.

————. 1928. Ethnobotany of the Meskwaki Indians. Bull. Public Mus. Milwaukee 4(2):[175]-326.

————. 1932. Ethnobotany of the Ojibwe Indians. Bull. Public Mus. Milwaukee 4(3):[327]-524.

————. 1933. Ethnobotany of the forest Potawatomi Indians. Bull. Public Mus. Milwaukee 7(1):[1]-230.

STEVENSON, M.C. 1915. Ethnobotany of the Zuni Indians. Annu. Rep. Bur. Amer. Ethn. 30:31-102.

STRAND, R. D., E. B. D. NEUHAUSER, and C. F. SORNBERGER. 1967. Lycoperdonosis. New England J. Med. 277(2):89-91.

TANTAQUIDGEON, G. 1928. Mohegan medicinal practices, weather-lore and superstition. Pp. 264-276 in Native tribes and dialects of Connecticut; a Mohegan-Pequot diary. (F. G. Speck, ed.). Annu. Rep. Bur. Amer. Ethn. 43:199-287.

TRAIN, P., J.R. HENRICHS and W.A. ARCHER. 1941. Medicinal uses of plants by Indian tribes of Nevada. (Contr. Toward a Flora of Nevada, No. 33). Washington, Div. Plant Expl. and Intro. Bur. Plant Industry, U.S. Dept. of Agric. 199 pp.

TURNER, N. J. 1978. Food plants of British Columbia Indians. Part II. Interior peoples. British Columbia Prov. Mus. Handbook No. 36, Victoria, British Columbia. 259 pp.

UMEZAWA, H., T. TAKEUCHI, H. IINUMA, M. ITO, M. ISHIZUKA, Y. KURAKATA, T. NAKAMURA, A. OBAYASHI and O. TANABE. 1975. A new antibiotic, calvatic acid. J. Antibiot. 28:87-90.

VESTAL, P. A. 1952. Ethnobotany of the Ramah Navaho. Pap. Peabody Mus. Amer. Arch. and Ethn. Harvard Univ. 40(4):1-94.

———— and R. E. SCHULTES. 1939. The economic botany of the Kowa Indians, as it relates to the history of the tribe. Botan. Mus., Cambridge, Massachusetts. 110 pp.

VOGEL, V. J. 1970. American Indian Medicine. Univ. Oklahoma Press, Norman. 583 pp.

WATLING, R. and M. R. D. SEAWARD. 1976. Some observations on puff-balls from British archaeological sites. J. Archaeol. Sci. 3:165-172.

WAUGH, F. W. 1916. Iroquis [sic] foods and food preparation. Canada Geol. Sur. Memoir 86: Anthrop. Ser., No. 12:1-235.

WESLAGER, C. A. 1973. Magic medicines of the Indians. Middle Atlantic Press, Somerset, New Jersey. 161 pp.

WYMAN, L. C. and S. K. HARRIS. 1941. Navajo Indian medical ethnobotany. Univ. New Mexico Bull.: Anthrop. Ser., V. 3, No. 5:1-76.

J. Ethnobiol. 3(1):63-73 May 1983

KEEPING OF STINGLESS BEES BY THE KAYAPO' INDIANS OF BRAZIL

DARRELL A. POSEY
Laboratório de Ethobiologia, Dept. de Biologia
Universidade Federal do Maranhão
65.000 São Luís, Maranhão, Brazil

ABSTRACT.–The Kayapo Indians of Brazil recognize 56 folk species of stingless bees, with an 86 per cent correlation with scientific classifications. Of these, nine species are considered semi-domesticates. Honey is an important nutritional element in the Kayapo diet; beeswax is believed to be a material link with the ancient world and is used to form a ceremonial hat *(mekutom)* that is a model of the universe.

INTRODUCTION

Previously I have pointed out the widespred use of insects by indigenous peoples in the lowland tropics of the New World (Posey 1978a, 1978b, 1980). Inevitably stingless bees (Meliponidae) are one of the most valued insect resources. Beekeeping for the Maya of Mesoamerica, for example, was an elaborate science (Schwarz 1948). For the Kayapo Indians of the middle Xingu region of Brazil, beekeeping is not as complicated as that of the Maya; however, knowledge and utilization of stingless bees is well-developed.

There are approximately 2,500 Ge-speaking Indians in the Kayapo nation, which is divided into nine widely dispersed villages in a two-million hectare *reserva indígena* in the Brazilian states of Pará and Mato Grosso. The data used in this paper were collected at Gorotire (7°48's, 51°7'W), the largest village (population approximately 600), during a 14-month field study conducted in 1977-78 (See Fig. 1).

As an athropologist with entomological training, I was initially attracted to the role of bees in the Kayapo culture by the elaborate semantic domain of social insects and by the extensive mythological corpus collected about social insect (Posey 1981a, in press). Social communities of *Hymenoptera* are thought to mirror Kayapo communities; indeed, it is believed that Indians learned how to live as social beings from an ancestral wise man *(wayanga),* who gained his knowledge from the study of bee, wasp, and ant behavior (Posey 1978a, 1979). This belief serves as a social charter to the Kayapo to continue their observations of nature in general and of *Hymenoptera* in particular and accounts for their reputation as keen ethologists (Posey 1981a, 1981b).

THE SOCIAL AND ECOLOGICAL CONTEXT

The Kayapo are excellent agriculturalists, but rely upon gathered foods as a major portion of their diet (cf. Bamberger 1967). The thoroughness of their ecological exploitation, and the wide variety of plants and animals utilized from that exploitation, have allowed the Kayapo to range over a variety of ecological zones effectively (Posey 1979, 1982).

The Kayapo recognize three major ecological zones:

1. *kapot* (campo) of which there are our types:
   a. *kapot-kên* – campos with short grasses;
   b. *kapot-kamepti* – campos with trees;
   c. *kapot-kam-bõiprek* – campos with high grasses;
   d. *pykati'ô'krãi* - campos with intermittant trees.
2. *krãi* (mountains), and
3. *bà* (forest) of which there are four types:
   a. *bà-kamrek* – gallery or riverine forest;

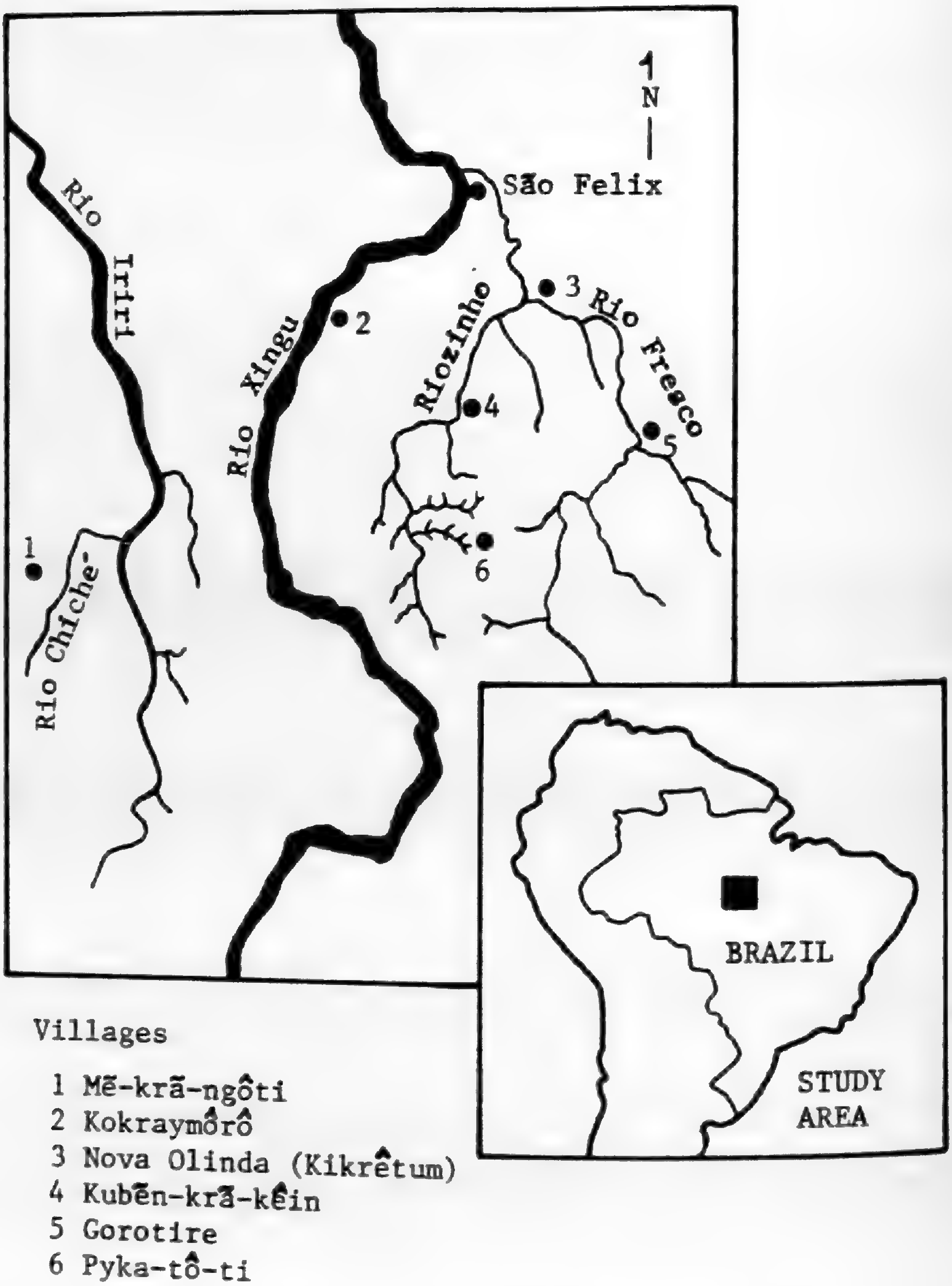


FIG. 1.–General Geographic Orientation of the Kayapo Indian Villages of Central Brazil.

b. *bà-epti* – dense jungle;
c. *bàkati* or *pi 'y-ko* – high forest; and
d. *bà-bàràrà* - forest with intermittent openings.

Native consultants (informants) were able to group stingless bees under these ecological zones with consistency, reflecting the various habitats frequented by the specific folk species of bees.

A morphological taxonomic system also exists, but the ability of the Indians to identify most bees out of their habitats is unreliable. A few species are widely known by men and women and can even be identified away from their nests (eg., *Apis mellifera*, *Melipona rufiventris flavolineata*, and *Trigona dallatorreana*). These are recognized by general morphological features such as body color, markings, and relative size. Out of a village population of approximately 600, I found only two bee "experts" who are reasonably consistent in identifying folk species from morphological characteristics alone. Both bee specialists were males. Women know little about bees since the collection of honey and wax rests within the male social domain.

During the dry season, groups of men often go off for days to procure honey. Honey is constantly sought on hunting trips and is highly prized. Meat and gathered foods are generally brought to the village and given to the wife or wife's mother (the eldest female of the household). She then distributes the meat or produce as she pleases among relatives. This is not the case with honey: a man is free to distribute honey as he pleases. Rarely does any honey ever reach the village, however, for it is usually drunk at the collection site.

The Indians make honey containers on the spot from multiple layers of banana leaves. The leaves are folded upward to form a collection vessel. When no honey remains in the vessel, the leaves are licked to glean the last drops that may have escaped through the leaf cracks.

The Kayapo masticate the thick bases of stalks of wild ginger until an absorbant brush-like object is produced. This is dipped into the honey and pulled through the mouth. This is an efficient way for several people to consume honey at the same time. Some Kayapo dispense with any proprieties and drink the honey like water. I have no data on how much honey is consumed by the average Kayapo in a year's time; however, I have seen a single Indian boy drink a half-liter of honey in one sitting. The Kayapo men like to drink honey until they feel light-headed (Posey 1981b).

Often sections of the nest combs that are filled with larvae, pupae, or pollen are also eaten. These have a very light, wafer-like texture and taste and are excellent when eaten with the honey and are as highly-prized as the honey itself (Table 1).

When honey is removed from the hive, a portion of the brood comb and honey is always left behind for *Bep-kororoti,* a powerful shaman who was taken into the sky in a flash of lightning. Functionally this secures the perpetuation of certain species that will return to re-colonize (Table 2). He resides in the clouds, or rather is the clouds, and sends lightning, thunder, and rain. Anyone who does not share with *Bep-kororoti* and his fellow Kayapo risks being struck by lightning.

Honey, wax, and bees are associated with the heavens and rains because of *Bep-kororoti's* penchant for honey. Bees wax is burned to produce a smoke that is believed to attract storm clouds and rains. The smoke is also believed to repel evil spirits, purge houses from lingering ancestral spirits, and protect children from witchcraft (cf. Posey 1981b, in press).

Beeswax is also used for many Kayapo artifacts. In most cases I was unable to ascertain if the bees wax had special ceremonial importance in artifact production, or if it served purely functional purposes.

Feathers and bow points are cemented into arrows with bees wax. Wax is also used to strengthen and lubricate bow strings. Black wax is used to darken cotton string that is used in making various wooden and bone artifacts (Posey 1978, in press).

The most impressive article made from bees was is the *me-kutom,* a hat worn by young men about to receive ceremonial names. The beeswax for these hats is inherited and stored as a ball in a hole in the earthen floor of the family's house. At the time of a name-giving ceremony, the wax ball is exhumed and formed into the *me-kutom* by a male relative of the boy.

The form of the *me-kutom* is highly symbolic (Figure 2). The front point of the *me-kutom* is called the "morning sky pole" *(kaikwa kratx);* the rounded back is the "evening sky pole" *(kaikwa-not).* These poles represent the beginning and ending points of the sun's path across the sky. The two "legs" *(pa)* are equivalent to north and south cardinal directions. There are painted patches on the *pa* that represent the idealized geographical relationships between village and fields. The village is the *nipok,* or center

TABLE 1.–*Principal species of Apidae utilized by the Kayapo Indians.*

Kayapo Name	Scientific Name	Wax Use Util.	Wax Use Cer.	Wax Use Med.	Honey Seasonal	Honey Amount	Larvae Eaten	Pupae Eaten	Pollen Eaten	Resin Used	Aggressive*	Distinctive Traits
ngài-pere-y	Apis mellifera	X	X		all year	very much			X		++++	Honey taken during New Moon
ngài-ny-tyk-ti	M. semiligra	X	X	X	dry seas.	average					++	Bee parts used for hunting magic
ngài-kumrenx	M. rufiventris	X	X	X	all year	average						Wax used for me-kutom
ngài-re	M. compressipes	X	X	X	all year	much						Has markings like the "anta"
ngài-kàk-ñy	Partamona sp.											Was used in magic to make enemy weak
mykrwãt	Frieseomelitta sp.	X	X	X	all year	average	X	X	X			
udjy	T. amalthea				dry seas.	average				X		Bee parts mixed with urucu for hunting magic
kukraire	T. dallatorreana				all year	much			X		+	Break off limb with nest and run to expell bees
mehnorã-kamrek	T. cilipes			X	all year	little				X		Has skinny eyes like jaguar
mehnorã-tyk	Scaura longula			X	all year	little				X		Used for jaguar hunting magic
kagnàrà-krã-kamrek	O. tataira	X	X	X	all year	average	X	X	X		+++	Cut entire tree to take honey
kangàrà-krã-tyk	Oxytrigona sp.	X	X	X	all year	average	X	X	X		++	Bee causes blisters on skin
kangàrà-udja-ti	Oxytrigona sp.	X	X	X	all year	average	X	X	X		+++	Bees used in hunting magic
kangàrà-ti	Oxytrigona sp.	X	X	X	all year	average	X	X	X		+++	Wax used for me-ktuom
myre	T. pallens.	X	X	X	all year	average					+	Sometimes fell tree
ngoi-tenk	Trigona sp.		X		all year	average						Live in termite nests
djô	T. fuscipennis	X	X	X	all year	little						Live in termite hills
imre-ti-re	T. chanchamayoensis				all year	little	X	X	X			Live in ant nests
kukoire-ka	Partamona sp.				all year	average					+	Nests in termite nests
o'i	Tetragona sp.				dry seas.	little						Very acidic honey; fell entire tree

TABLE 1.–*Principal species of Apidae utilized by the Kayapo Indians* (continued)

Kayapo Name	Scientific Name	Wax Use Util.	Cer.	Med.	Honey Seasonal	Amount	Larvae Eaten	Pupae Eaten	Pollen Eaten	Resin Used	Aggres-sive	Distinctive Traits
ton-my	Tetragona sp.	X	X	X	dry seas.	average				X		Fell tree to take honey
ri	Tetragona sp.	X	X	X	all year	much				X		Bee thought to be "stupid" and weak
mehn-xi-we'i	Tetragona goettei	X	X	X	all year	average						Found only in the Xingu
menire-udja	T. quadrangula	X	X	X	all year	average						Opening of nest like a vagina
mehnodjanh	F. varia			X	dry seas.	little				X		Smoke from wax used for curing
mehñykamrek	T. spinnipes	X	X	X	dry seas.	little	X	X	X		+	Wax burned; smoke causes dizziness
mehñy-tyk	T. banneri	X	X	X	dry seas.	little					+	
pyka-kam	T. fulviventris	X	X	X	dry seas.	little				X	+	Bee deposits drops of resin on skin

*Nests of Aggressive (+++ - very aggressive; ++ - moderately aggressive; + - slightly aggressive) bees are raided using smoke and fire to expell bees first. Wax use: Utilitarian; Ceremonial; Medicinal.

TABLE 2.–*Semi-domesticated (manipulated) species of APIDAE utilized by the Kayapo.*

Kayapo Name	Scientific Name
*Ngài-pere-y	*Apis mellifera* Linn.
*†Ngài-ñy-tyk-ti	*Melipona seminigra cf. pernigra* (Moure & Kerr)
*†Ngài-kumrenx (mehn-krak-krak-ti)	*Melipona rufiventris flavolineata* (Friese)
*Ngài-re	*Melipona compressipes cf. fasciculata* (Smith) or *afinis* Moure Ms.
*mykrwat	*Frieseomelitta* sp.
*†udjy	*Trigona amalthea* (Olivier)
*†kukraire	*Trigona dallatorreana* Friese
mehnorã-kamrek	*Trigona cilipes pellucida* (Ckll.)
mehnorã-tyk	*Scaura longula* (Lep.)

†Those species whose nests are taken to the village.
Those species that are encouraged to build nests in dry posts in the houses.
*These species are systematically raided in subsequent seasons.

circle. The circle also represents the sun. The smaller circle inside the *nipok* represents the moon superimposed over the sun. The painted paths from the sky poles indicate the paths of the sun and moon through the sky *(kaikwa)* and over the earth *(pyka)*.

From a side view (Figure 3), the *me-kutom* represents another plane and the relationship between sky and earth. The wax hat itself is seen as a floating somewhat concave, disc with small "feet" *(pa)*. The circle *(nipok)* as seen from above is really an elevated hump into which is inserted a thin stick. Onto the stick is woven an arch of bamboo and cotton. Macaw feathers are inserted into the bamboo to produce a radiating arc of red and blue feathers. This represents the sky *(kaikwa)*. The Kayapo believe they once lived above the sky and lowered themselves to the earth by means of a woven cotton rope that was dropped through an armadillo hole. The stick represents the cotton string that once brought the Kayapo from the upper world to the earth (Posey 1981b).

It is said that the wax used for the *me-kutom* is the same as that brought by the ancient Kayapo from the sky. It is a direct and highly valued link with the very origins of Kayapo culture. It is the one material continuity the Kayapo of today have with their most ancient ancestors.

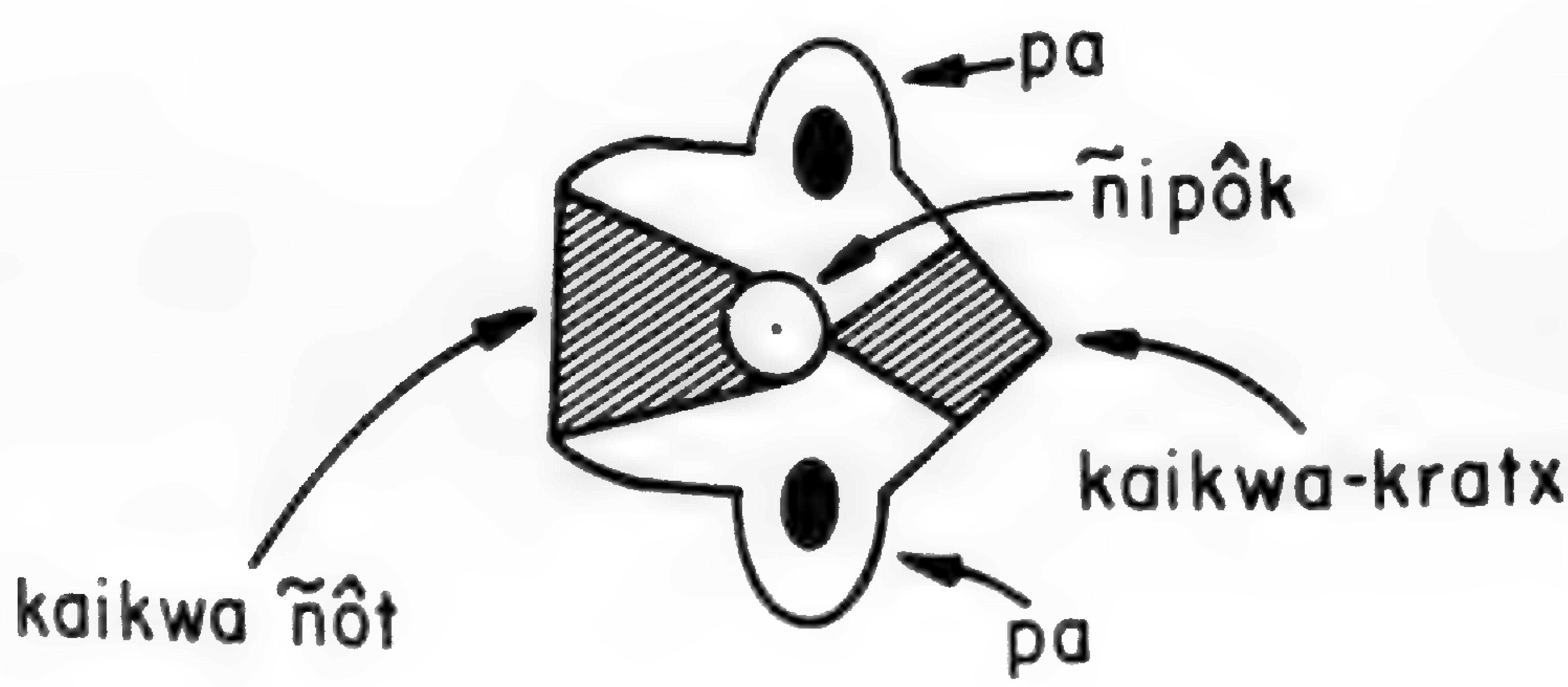


FIG. 2.–An Overview of the *me-kutom*, showing major symbolic components.

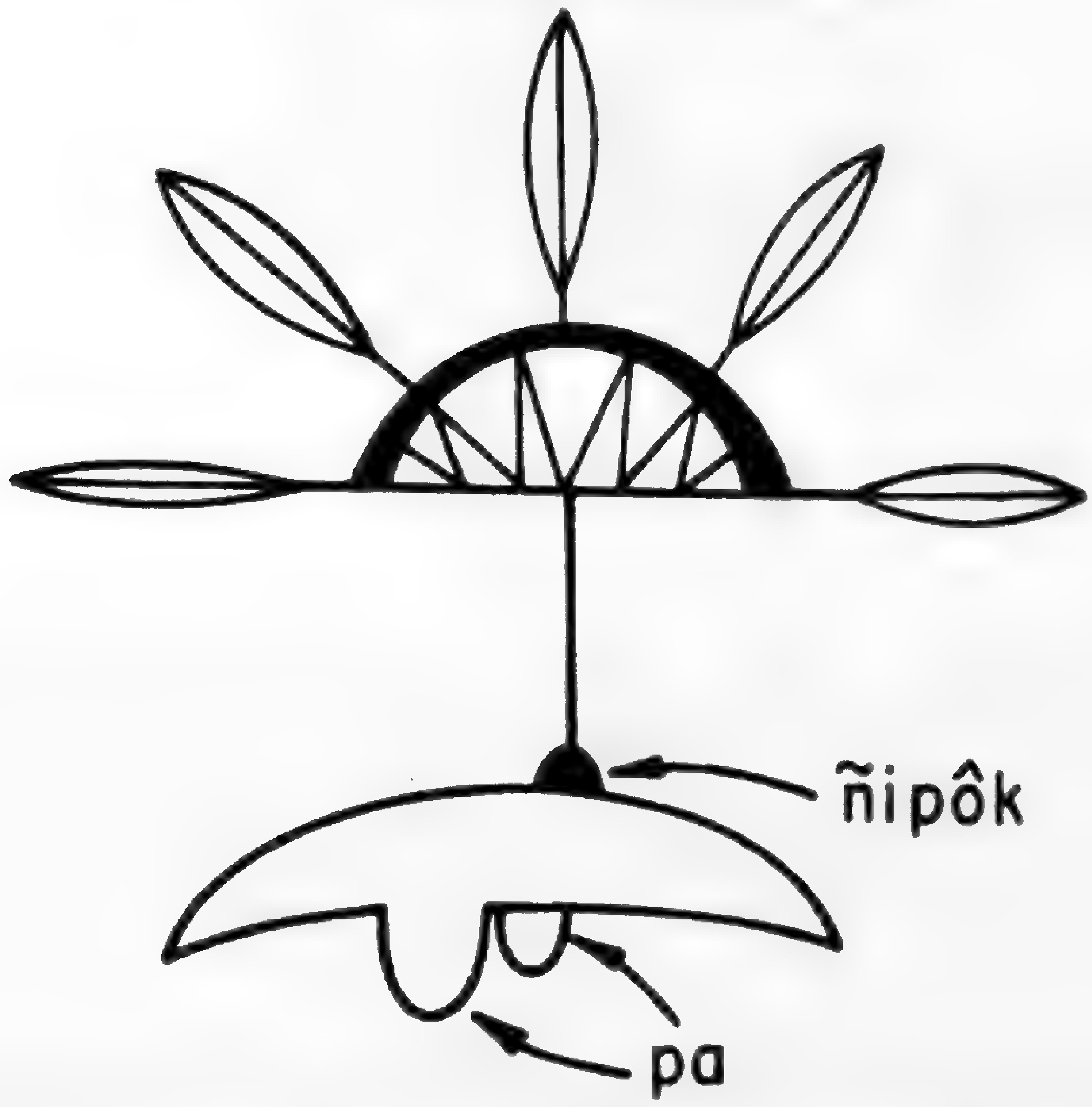


FIG. 3.—A lateral view of the *me-kutom,* showing the symbolic relationships between earth *(pyka)* and sky *(kaikwa).*

CLASSIFICATION AND BEEKEEPING

As is frequently discovered in folk biology, several taxonomic systems seem to be superimposed and a particular classification paradigm brought to play depending on functional context (Gardner 1976). One "functional" classification system is based on the aggressive behavior of the bee when disturbed. There are four major divisions in this system: (1) docile, (2) stinging, (3) biting, and (4) blister-causing. The two "stinging" bees are the non-native European and the hybrid Brazilian bee *(Apis mellifera).*

This Brazilian bee is a source of great concern for the Kayapo because of its aggressive behavior. Since its arrival in the area (the Indians say it arrived in 1966 during the February full moon), the Brazilian bee has driven out or taken over the nests of native bees. The Kayapo claim that the availability of native bee honey has drastically declined because of the colonizing exuberance of the *Apis mellifera.* The Kayapo have grown to like the abundant, sweet honey of the *Apis mellifera (ngai-pere'y),* but still prefer the flavor of the honey from stingless bees.

There is an elaborate system of bee classification based on nest structure and location of the nest. Nests are grouped by: (1) nest site (in a tree, in the earth, in vines, in abandoned termite hills, etc.); (2) the height of the nest from the ground; (3) the shape and size of the entrance tube (length, shape, markings, size, etc.); and (4) nest size (based on gross size, relative amount of honey per nest, etc.). These criteria correlate closely with Willie and Michener's (1973) descriptive typology.

Nests are raised using strategies consistent with the aggressive nature of the species. For the most violent bees *(akre),* fire and smoke are used to expel the colony before the nest is opened. If the nest is high up in a tree, the entire tree will be felled in order to get the nest. For less aggressive species *(wajobore),* the Indians tackle the nest with axes and bare hands, despite clouds of furious, swarming insects (Posey 1981b). Table 1 summarizes characteristics of principal species recognized by the Kayapo.

The Kayapo recognize six species whose nests can be raided and, if the queen and part of the brood chamber are returned to the nest, the bees will return to re-establish the colony. Thus there are trees known by, and in a sense owned by, certain Kayapo men that are consistently raided year after year (Table 2).

The Kayapo also "keep" several species in or nearby their houses. For example when nests of certain species of *Trigona* (T. *dallatorreana* and one unidentified species) are found in the forest, they are brought back still attached to their limbs and the complete nests erected from an eave of the house. Yet other species (T. *amlthea* and *M. rufiventris)* are brought with the nest intact in a hollow log and placed at the margin of the forest near the village or field clearing. Other species *(T. cilipes* and *S. longula)* tend to prefer building sites in exposed rafters of houses and are allowed to co-exist with the household residents. The nests of all of these "kept" species are raided at prescribed times when the honey cache is known to be optimal.

The Kayapo also encourage the establishment of bee nests in their fields. To do this, they sometimes dig large holes or utilize existing armadillo holes. Into these holes they place logs, which attract several *Trigona* species (including *T. fuscipennis* Friese). *T. fulviventris guinae* Ckll. nests directly in the earthen walls of the hole. The presence of bees is associated by the Kayapo with crop success, although there is no clear notion of pollination per se. I do not know about the actual role of pollination by these species.

In my collection of bees from Gorotire, 56 folk species were discerned (Table 3). J. M. F. Camargo, Universidade de Sao Paulo, Riberao Preto, kindly inspected and identi-

TABLE 3.–*Species of APIDAE found in the Gorotire (Kayapo) Collection.*

Family, Genus, Species	Collection Code Number[1]
ANTHRPHORIDAE	
Xylocopa (Schoenherria) dimidiata Latr.	540 - 2
X. (Schoenherria) lucida Smith	112 - 1
X. (Schoenherria) anthophoroides Smith	507 - 1
X. (Megaxylocopa) frontalis (Oliver)	540 - 1
Centris (Centris) inermis Friese	422, 479 - 6
C. (Centris) flavifrons (Fab.)	sem no - 1
C. (Centris) aenia Lep.	sem no - 1
C. (Centris) spilopoda Moure	117 - 1
C. (Paremisia) similis (Fab.)	442 - 2
C. (Paremisia) dentata Smith	442 - 3
C. (Trachina) longimana (Fab.)	540 - 2
C. (Heterocentris) bicornuta Mocs.	103, 104 - 2
C. (Centris) sp 1	113, 114 - 2
C. (Centris) sp 2	111 - 1
C. (Paremisia) sp	35 - 1
C. (Hemisiella) sp	105 - 1
C. (Melanocentris) sp	119, 120, 118 - 3
Mesoplia sp (parasita)	278 - 1
Mesonychium asteria (Smith) (parasita)	603 - 1
Tetrapedia sp	222 - 1
HALICTIDAE	
Halictus hesperus (Smith)	88 - 2
Neocorynura sp	280 - 1
Augochloropsis sp	451 - 1
MEGACHILIDAE	
Megachile brasiliensis DallaTorre	99 - 1
M. (Austromegachile) sp	98 - 1
M. (Crysosaurus) sp	107 - 1
M. cf. *giraffa* Schrottky	97 - 1
Megachile sp 3	331 - 1
Megachile sp 2	101 - 1
Megachile sp 1	532 - 1

TABLE 3.–*Species of APIDAE found in the Gorotire (Kayapo) Collection.* (Continued)

Family, Genus, Species	Collection Code Number
APIDAE	
Bombinae	
Euglossini	
Eulaema (Eulaema) meriana (Olivier)	540 - 2
Apinae	
Apis mellifera (L.)	218, 109, 106, 110, 108, 340
Meliponinae	
Meliponini	
Melipona rufiventris flavolineata (Friese)	547 - 2
M. tumupasae Schwarz	331, 541, 332, 325 - 4
M. seminigra cf. pernigra (Moure & Kerr)	340 - 1
M. compressipes cf. fasciculata (Sm) or *afinis* (Moure Ms)	542 - 1
TRIGONONI	
Paratrigona (Paratrigona) cf. peltata (Spinola)	554 - 1
Oxytrigona tataira cf. flaveola (Friese)	555, 553 - 4
Plebeia (Plebeia) minima (Gribodo)	520 - 1
Scaura (Scaura) longula (Lep.)	sem no - 1
Cephalotrigona capitata femorata (Smith)	509 - 1
Trigona (Trigona) spinipes (Fab.)	328 - 6
T. (Trigona) fuscipennis Friese	557, 89, 71 - 6
T. (Trigona) amalthea (Olivier)	343, 504, 475, 94, 343 - 7
T. (Trigona) fulviventris guianae Ckll.	466 - 1
T. (Trigona) chanchamayoensis Schwarz	44 - 1
T. (Trigona) pallens pallens	515 - 1
T. (Trigona) cilipes pellucida (Ckll.)	sem no - 1
T. (Trigona) dallatorreana Friese	546, 473 - 3
T. (Trigona) branneri Ckll.	516 - 2
Partamona (Partamona) pseudomusarum Camargo	512 - 7
P. (Partamona) cf. cupira (Smith)	96 - 1
P. (Partamona) sp 1	334, 356? - 2
P. (Partamona) sp 2	581 - 1
Nannotrigona (Scaptotrigona) nigrohirta Moure Ms.	339, 550 - 5
N. (Scaptotrigona) polysticta Moure	342 - 3
Tetragona (Tetragona) quadrangula (Lep.)	432, 512 - 3
T. (Tetragona) goettei Friese 1900	436, 437, 435 - 9
T. (Tetragona) clavipes (Fab.)	522, 338 - 4
T. (Tetragona) dorsalis (Sm.)	536, 327, 506 - 11
T. (Tetragona) sp	86 - 1
T. (Ptilotrigona) lurida (Sm.)	604 - 1
T. (Tetragonisca) angustula fiebrigi (Schwarz)	508 - 2
Frieseomelitta cf. varia (Lep.)	519, 513 - 3
Frieseomelitta sp	85 - 1
Frieseomelitta cf. modesta Moure Ms.	558 - 5

fied the Gorotire collection. He found 66 scientifically recognized species of which 11 were unknown or as yet not described (one species of *Frieseomelitta;* two of *Partamona;* one of *Tetragona;* two of *Centris;* three of *Megachile;* one of *Mesoplia;* and one of *Tetrapedia).*

In a normative comparison between folk and scientific species, therefore, we find that there is approximately an 86% correlation. Such high correlative quotients are not uncommon (Berlin 1973, Hunn 1975). The complete species list is found in Table 3.

CONCLUSION

Bees and other social insects are of great symbolic importance to the Kayapo Indians. The organization of the Hymenoptera is believed to be the basis of human social and political organization. Honey and beeswax are directly related to *Bepkororoti,* a central mythological figure who controls rain and lighning. The beeswax *mekutom* is a symbolic representation of the Kayapo world and is said to be the one material link to origins of the Kayapo people.

Various folk taxonomic systems operate to classify the 56 folk species of stingless bees recognized by the Kayapo. The Kayapo utilize nine major "ecozones" to group bees by nesting sites. Other taxonomic paradigms take into account specific nest types and exact locations within a given "ecozone." A morphological taxonomy also exists, but appears to be utilized by only a few bee "experts." Utilitarian considerations seem to forge the predominant taxonomic system, taking into account the behavior of the bees, honey taste and wax type.

There is an 86% correlation between folk species and scientifically determined species listed in Table 3. It is clear that the Kayapo are keen observers of nature in general and *Meliponidae* in particular. Bees are an important economic source to tropical forest peoples like the Kayapo Indians of Brazil.

ACKNOWLEDGEMENTS

This research was funded by the Wenner-Gren Foundation for Anthropological Research. I would like to thank the staffs of FUNAI, INPA, CNPq, and the Museu Paraense Emilio Goeldi for their cooperation and assistance. Particularly I would like to acknowledge the assistance of Kwyra-ka and Ira Kayapo; also the continued support of Lauro Menescal, chefe do Posto Gorotire. Without these people, this project would have been impossible. Scientific identification of the insect specimens was graciously provided by J.M.F. Camargo, Faculdade de Medicina, Universidade de Sao Paulo, Riberao Preto, Brazil. To him I am especially grateful.

LITERATURE CITED

BAMBERGER, JOAN. 1967. Environmental and Cultural Classification: A Study of the Northern Cayapo. Unpubl. Ph.D. dissert. (Anthrop), Harvard Univ.

BERLIN, B. 1973. Folk Systematics in Relation to Biological Classification and Nomenclature. Ann. Rev. Ecol. Syst. 4:259-271.

GARDNER, P. 1976. Birds, Words, and a Requiem for the Omniscient Informant. Amer. Ethnol. 3:446-468.

HUNN, E.S. 1975. A Measure of the Degree of Correspondence of Folk to Scientific Biological Classification. Amer. Ethnol. 2:309-327.

POSEY, D.A. 1978a. Ethnoentomology of the Gorotire Kayapo of Central Brazil. Unpubl. Ph.D. dissert., Univ. of Georgia, Athens.

_________ 1978b. Ethnoentomological Survey of Amerind Groups in Lowland Latin America. The Florida Entomol. 61(4):225-229.

_________ 1979. Kayapo Controla Insectos com Uso Adequado do Ambiente. Revista de Atualidade Indigena 3(14):47-58.

_________ 1980. Algunas Observaciones Etnoentomologicas sobre Grupos Amerindos en la America Latina. America Indigena 15(1): 105-120.

_________ 1981a. Wasps, Warriors, and Fearless Men: The Cultural Ecology of the Kayapo Indians of Central Brazil. J. Ethnobiol. 1: 165-174.

_________ 1981b. Apicultura Popular dos Kayapo. Revista de Atualidade Indeigena 20(1):36-41.

_________ 1982. Development of the Amazon

LITERATURE CITED (continued)

on an Indigenous Model. The Dilemma of Amazonian Development (Emilio Moran, ed.). Westview Press.

———— In press. Ethnomethodology as an Emic Guide to Cultural Systems: The Case of the Insects and the Kayapo Indians of Amazonia. Anuario Antropologico 82.

———— In press. The Importance of Bees to the Kayapo Indians of the Brazilian Amazon. Florida Entomol.

———— In press. Folk Apiculture of the Kayapo Indians of Brazil. Biotropica.

SCHWARTZ, H.F. 1948. Stingless Bees (Miliponidae) of the Western Hemisphere. Bull. Amer. Mus. Nat. Hist. Vol. 90.

TURNER, T. 1965. Social Structure and Political Organization among the Northern Cayapo. Unpubl. Ph.D. dissert., (Social Relations), Harvard Univ.

WILLIE, ALVARO and C. MICHENER. 1973. The Nest Architecture of the Stingless Bees with Special Reference to those of Costa Rica. Revista de Biologia Tropical 21 (Suplemento 1).

NOTES

The Collection Code Numbers refer to specimens from the Gorotire collection that are now in the possession of J.M.F. Carmargo, Dept. de Biologia, Universidade Federal do Maranhao, 65.000 Sao Luis, MA (Brazil).

Book Review

Photomicrographs of World Woods. Anne Miles. 233 pp. illus. Department of the Environment, Building Research Establishment. Her Majesty's Stationery Office, London. 1978. 20.00 Pounds Sterling.

Although this volume may not appeal to the entire readership of the *Journal of Ethnobiology,* it will be a welcome discovery for the archaeobotanist, paleoecologist, plant anatomist, wood technologist, dendrochronologist, or plant taxonomist. Miles has assembled photomicrographs of over 450 species in more than 375 genera of important Angiosperm and Gymnosperm timbers. Each species is illustrated in transverse, radial, and tengential views at 25 to 60 magnifications in black and white photographs. The resolution is so fine that pit structure can be determined on the individual vessel elements. One could do a detailed phylogenetic study of wood evolution, using only the photographs in this book.

Of course it is impossible to illustrate all woody plants found on earth but Miles has included enough species to give a detailed picture of the range of variation within individual families and genera. This volume is slightly biased toward Old World species, but there is excellent coverage of both temperate and tropical, as well as northern and southern hemisphere genera. In any problem of plant identification, there is no substitute for reliable comparative material, but this volume should prove to be a good starting point and an invaluable reference tool.

CHM

J. Ethnobiol. 3(1): 75-95 May 1983

ARCHAEOLOGICAL ASSESSMENT OF SEASONALITY FROM FRESHWATER FISH REMAINS: A QUANTITATIVE PROCEDURE

DARCY F. MOREY
Department of Anthropology, University of Tennessee
Knoxville, TN 37916

ABSTRACT.—Reliable, replicable procedures for archaeological assessments of seasonality in North America are needed. This paper presents a procedure for determining season of death of archaeological freshwater catfish *(Ictalurus)* based on analysis of measurements on incremental growth structures in pectoral spine thin sections from modern catfish from the Middle South. The measurements are regressed with the date of death of each specimen, resulting in a quantitative model for predicting the date of death of specimens for which this is unknown. The predictive reliability of the model is assessed with a "blind" test on modern specimens. Evaluation of modern specimens from regions north of the Middle South suggests that predictive error results when specimens from more northerly latitudes are assessed, though results are still usable. The procedure is applied to a sample of pectoral spines from the Schmidt site (25HW301), a late prehistoric Central Plains Tradition settlement in central Nebraska. This site was the object of a larger study of subsistence and seasonality among horticulturalists in the Central Plains. Without this analysis little reliable seasonal evidence would have been available.

INTRODUCTION

Seasonality studies are assuming an important role in current archaeological research (cf. Monks 1981 and references contained therein). In spite of a growing interest in archaeological seasonality studies, reliable, replicable procedures for assessing seasonality are generally lacking in North America. However, recent research is helping to correct this problem. For example, procedures have been developed for determining seasonality of large scale aboriginal bison kills in the North American Plains (e.g. Frison and Reher 1970; Reher 1974; Frison 1978). Unfortunately, the data base upon which this work rests is unavailable to most archaeologists. Research being conducted in coastal areas around the world is also producing reliable procedures for assessing seasonality through analysis of incremental growth structures in the hard parts of archaeologically represented marine organisms (e.g. Coutts 1970; Coutts and Higham 1971; Coutts and Jones 1974; Ham and Irvine 1975; Aten 1981).

Although the procedures developed for assessing seasonality from remains of marine organisms have produced sound results, they have no direct application in non-coastal situations. Moreover, comparable (i.e. reliable) procedures for assessing seasonality from incremental growth structures in non-marine organisms have not been developed. Archaeologists have attempted to derive seasonal information from incremental growth structures in mammal teeth (Benn 1974; Kay 1974; Spiess 1976, 1978, 1979; Lippincott 1976; Adair 1977; Bourque et al. 1978; Monk and Bozell 1980; Bozell 1981), fish scales (e.g. Artz 1980; Peterson 1980) and fish vertebrae (Casteel 1972). No one has demonstrated that seasonal interpretations based on mammal teeth are reliable and even the fish studies, which are clearly promising, suffer from subjective evaluation criteria and a lack of demonstrated validity.

Seasonal analysis of archaeological fish remains has been inspired largely by the existence of established criteria for aging modern fish from scales. The principles underlying aging techniques (and, by extension, techniques for deriving seasonal information) have been summarized many times (e.g. Lagler 1956; Casteel 1976; Bagenal and Tesch 1978; Peterson 1980). Briefly, fish are poikilotherms; their metabolic rate fluctuates in relation to the surrounding water temperature. Thus, growth rate decelerates during cold periods (late fall and winter) and accelerates during warm periods (spring and summer). Undoubtedly other factors such as food availability, population density and local water conditions also affect seasonal growth rate. The end of a period of decelerated growth is visible on a fish scale as a narrow zone of closely spaced circuli, the outer edge of which is called an arrest line or annulus. By determining what stage of growth is represented on the outer edge of the scale when the fish died, an estimate of season of death can be made.

Fish scales present some problems. First, they are not readily preserved in or recovered from archaeological contexts. Even when preserved they are fragile and easily damaged by routine field and laboratory processing procedures. In addition, one fish may have hundreds of scales and, therefore, there is no reliable way of estimating how many fish a series of scales represents. It is logical, therefore, to assume that fish bones might provide an appropriate and more readily usable medium for assessing seasonality.

Fortunately, investigating seasonality from fish bones does not require starting from scratch. Fish of the North American family Ictaluridae (catfish) are scaleless; yet there exists substantial literature on aging modern catfish from bones, principally vertebrae and pectoral spines (Lewis 1949; Appelget and Smith 1951; Sneed 1951; Schoffman 1954, 1955; Forney 1955; Marzolf 1955; Jenkins 1956). Three important points emerge from this research: (1) when viewed properly, catfish vertebrae and spines exhibit arrest marks analogous to arrest marks on fish scales, (2) these arrest marks are formed annually (one each year) with a high degree (perhaps 85%) of reliability (cf. Appelget and Smith 1951; Sneed 1951; Marzolf 1955) and (3) on average, catfish grow at approximately the same rate from year to year throughout life (Appelget and Smith 1951; Sneed 1951). With regard to the latter point, while extensive data compiled in Carlander (1969:538-554) also suggest that this is generally true, some catfish populations do show variability in yearly growth rates (usually decelerated growth), especially among older age groups (about 7-8 years and older).

Ictalurids have several additional things to recommend them for archaeological analysis. Catfish are abundant and widespread and are commonly represented in archaeological contexts in many parts of North America. Their cranial elements and spines are easily recognizable and comprehensive osteological guides are available (Mundell 1975; Grizzle and Rogers 1976:74-85). If specific identification is desired several keys may be consulted (Paloumpis 1963, 1964; Calovich and Branson 1964; Krause 1977).

Correct interpretation of seasonal growth in archaeological samples of any species depends on (1) an understanding of seasonal growth patterns in modern individuals and (2) the validity of the necessary analogy between modern samples and archaeological samples. Therefore, in 1980 a study of seasonal growth in modern catfish was initiated (Morey 1981), leading to the development of a procedure for assessing seasonality from archaeological catfish remains (Morey 1982:76-102).

ANALYSIS OF SEASONAL GROWTH IN MODERN CATFISH SPINES

This research is based on analysis of seasonal growth in pectoral spines of modern channel catfish *(Ictalurus punctatus)*. Pectoral spines are paired in each individual (Fig. 1); they are compact and durable and are as likely to preserve archaeologically as most other animal bones. The modern sample consists of 97 specimens from fish taken from one of three locations in the Middle South[1]: the impounded Tennessee River in Decatur County, Tennessee (n-55); the unimpounded Duck River in Maury County, Tennessee (n=27); and the impounded Cumberland River in Trigg County, Kentucky (n=15). The years 1978, 1980 and 1981 are represented. Based on annuli counts, 80 of the 97 (82.5%) fish represented were six years old or less when they died. Linear regression is used to compare two variables, the date of death and a calculated growth index from each specimen[2].

Growth Index.–In order to calculate the growth index it is necessary to obtain thin sections of each pectoral spine. Figure 1 shows a pectoral spine with the sectioning point illustrated. The sectioning point follows Marzolf (1955) and Sneed (1951). One spine,

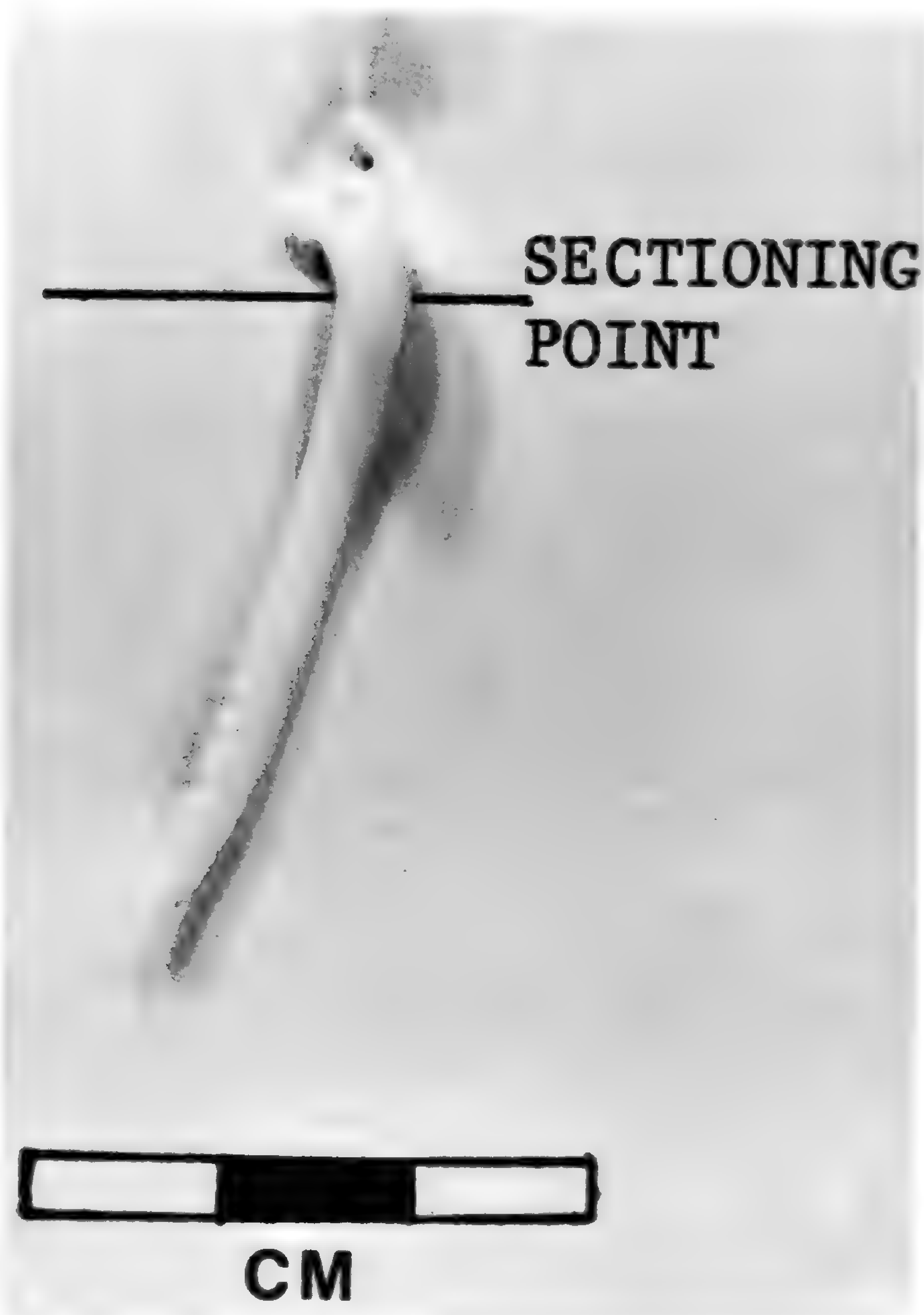


FIG. 1.–Photograph of a catfish pectoral spine, showing the sectioning point.

usually the right, is used from each modern fish. They are cut on a Buehler Isomet low speed wafering saw. Thickness is not critical; most sections used vary between 200 and 400 microns. No grinding, polishing, embedding or chemical staining is necessary with modern specimens; untreated sections are stored in a small vial containing a mild water/ethanol solution. To view them they are removed from the solution, dried, and placed on a glass slide.

When viewed microscopically with polarized transmitted light the sections show arrest marks which appear as continuous, narrow, dark blue bands visible on all portions of the section. These reflect arrested growth during winter/early spring. Following Marzolf (1955), the entire darkened arrest line is regarded as an annulus. Areas reflecting accelerated growth are visible as wider, whitish zones between annuli. In most fish the transition between arrest lines and zones of accelerated growth is distinct. Figure 2 shows a schematic view of a pectoral spine thin section. Arrest lines (i.e. annuli) are illustrated with reference to two measurement locations, A and B, on the posterior portion of the section. The two lines which encompass B represent the most recent *full* yearly growth increment. The measurement points are from *inner edge to inner edge* of the last two annuli. Measurement A represents the most recent *partial* yearly growth increment. It is taken from the inner edge of the last annulus to the edge of the spine. The measurements are taken with an ocular micrometer in units of .01 mm.

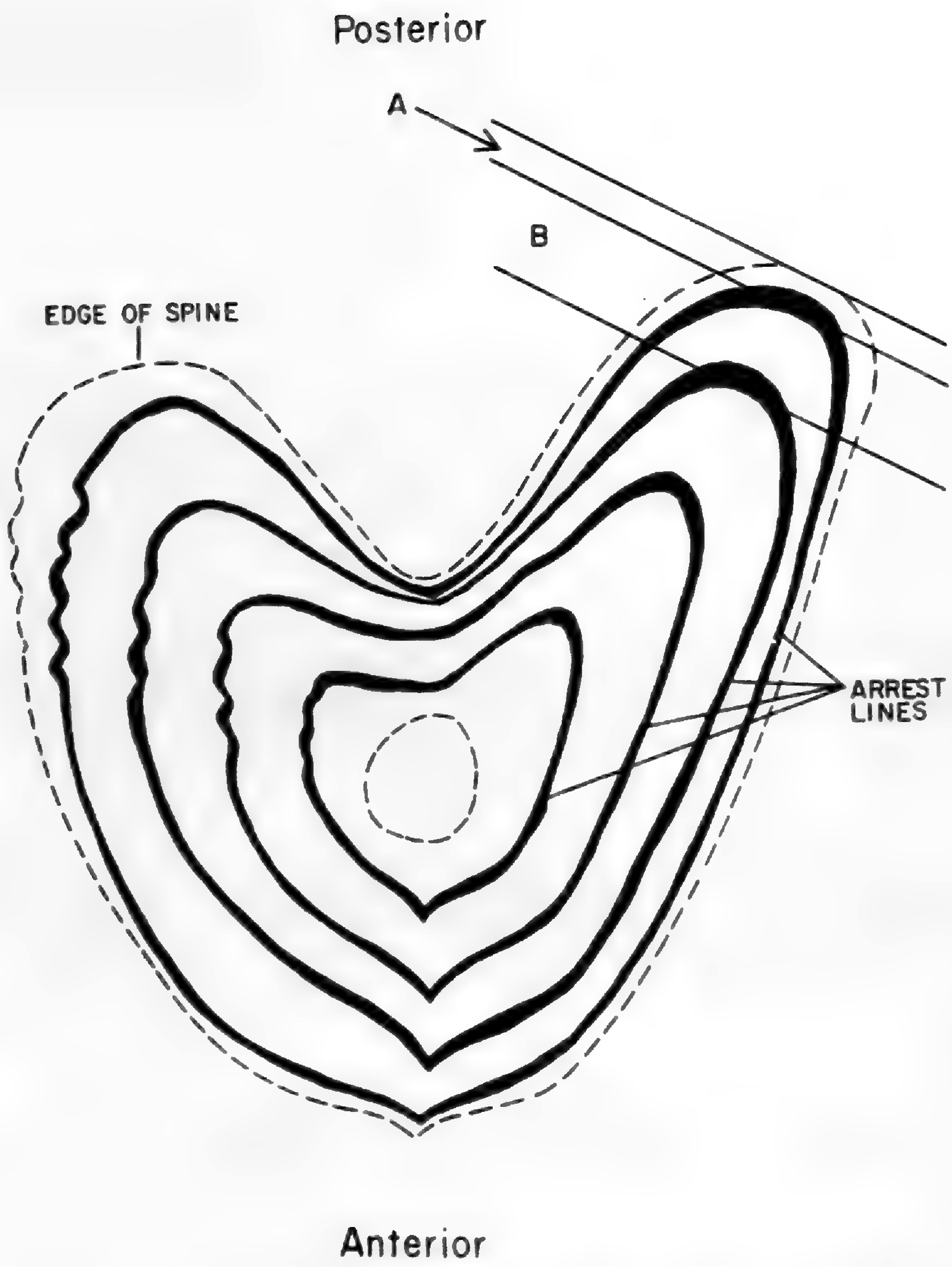


FIG. 2.–Schematic view of a catfish pectoral spine thin section, showing the location of measurements A and B.

Measurements A and B are used to calculate the growth index:

$$\text{Growth Index} = \frac{A}{B} \times 100$$

Figure 3 shows two photomicrographs of a pectoral spine thin section from a Duck River (Maury County, Tennessee) catfish that died on July 12, 1980. The location of measurements A and B is illustrated.

As previously noted, earlier research suggests that channel catfish tend to grow at approximately the same rate from year to year (Appelget and Smith 1951; Sneed 1951). If this is the case, it is reasonable to expect a regular decrease in the absolute distance between annuli from year to year since the structure being added to is progressively larger each year. This prediction can be tested by defining a new variable, P. P, for any given full increment, is the ratio of its own width to the width of the previous full increment, expressed as a percent. If the prediction holds, the mean value of P for all year classes should be about the same. To insure adequate sample sizes these data have been

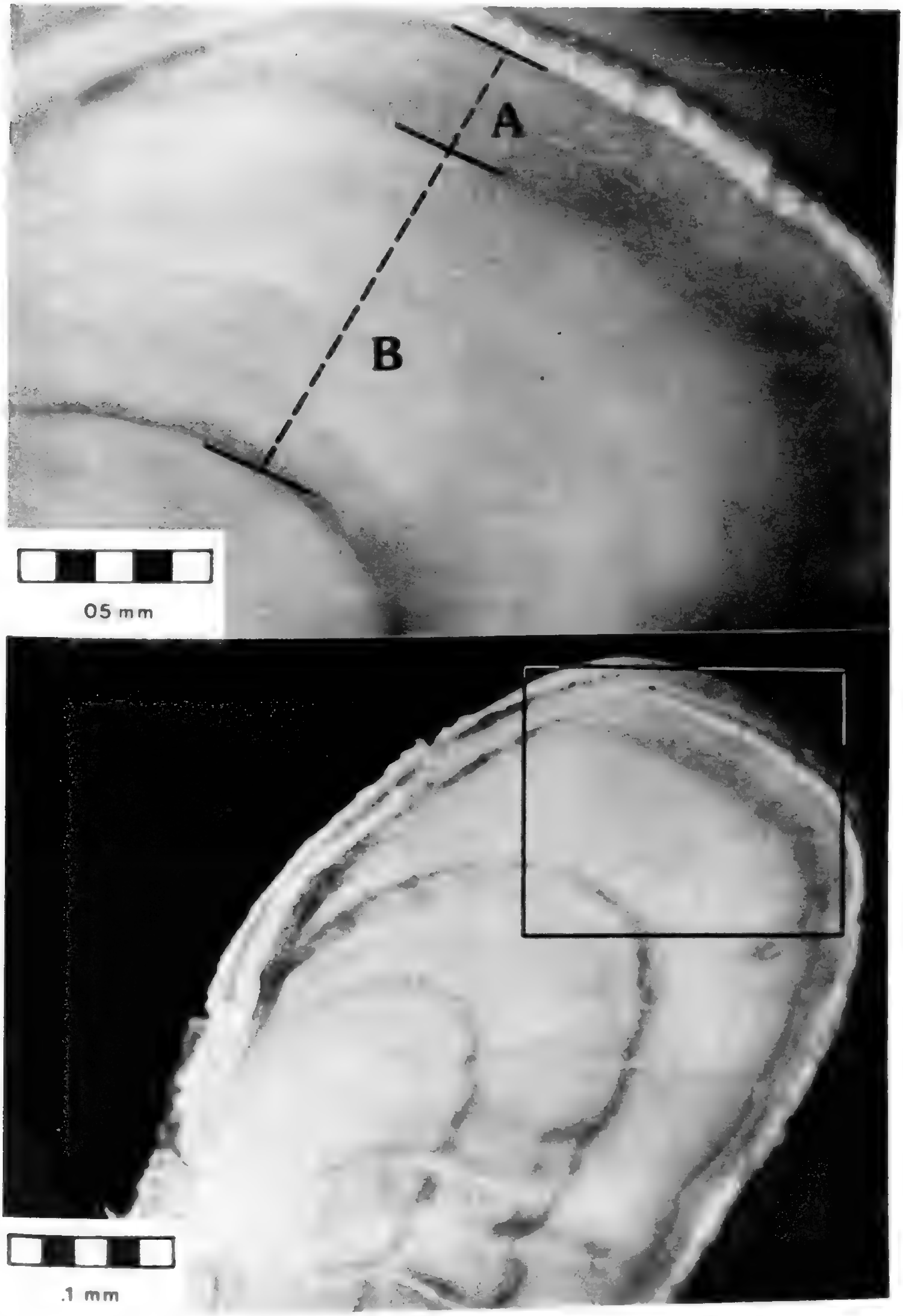


FIG. 3.–Two photomicrographs of a pectoral spine thin section from a Duck River (Maury County, Tennessee) catfish that died on July 12, 1980, with the location of measurements A and B illustrated. The upper half is an enlargement of the contained area in the lower half.

assimilated for all year classes with 25 or more observations, which includes year classes 2-5. The mean value of P for these year classes is presented below:

Year Class	Mean of P
2	85.32
3	83.36
4	76.19
5	81.15

These data suggest that, at least during years 2-5, a fish is likely to produce an increment with a width of approximately 75-85% of the previous increment. In other words, a spine from a three year old catfish with a growth index of 30 is probably comparable to a five year old catfish with a similar growth index.

Date of Death.—Date of death for each specimen is recorded as a whole number from 1-52. A fish that died in the first week of January is assigned a value of 1, a fish that died in the second week a value of 2, and so on through 52 for a fish that died in the last week of December. The starting point for this scale is more than a matter of convenience; a sample of mid-January fish consistently showed the initial stage of annulus formation on the outer edge of the spine whereas a mid-December sample from the same calendar year did not. Recognizing that there is undoubtedly year to year variation in the time when annuli begin to form in most fish, January 1-7 is a reasonable estimate based on the data at hand. Annulus formation in catfish pectoral spines seems to take several weeks, beginning in mid-winter and terminating in the spring, perhaps in April, when accelerated growth resumes.

Aberrant Specimens.—Overall, approximately 15-20% of the modern specimens examined were rejected due to aberrant irregularities in growth. Sometimes annuli are too indistinct to permit reliable measurement. Occasionally a fish produces an arrest mark that is not annual, called a false annulus. False annuli are usually less distinct than true annuli and result in obvious departure from the normal pattern (i.e. gradual reduction in absolute increment width from year to year). Fish showing a false annulus in either of the increments used to calculate the growth index are rejected.

Sometimes a fish shows irregularities which cannot clearly be attributed to false annuli (i.e. the arrest marks are uniformly distinct). During the course of this research such specimens were accepted or rejected on the basis of my subjective impression as to their degree of regularity. Anticipating archaeological application, this may be operationalized to produce a replicable rejection criterion. To do this it is necessary to return briefly to a consideration of the variable P. The means of P for year classes 2-5 are comparable; therefore, the raw data have been pooled to produce a grand mean of P for these year classes which is 79.7. The standard deviation of the pooled data is 27.558. By considering 1.5 standard deviations (41.3), an arbitrary decision, it can be stated that approximately 87% of the P values from fish considered acceptable fall within a range of 79.7 + 41.3 if a normal distribution is assumed (cf. Arkin and Colton1963:119). Therefore, a rejection criterion for future specimens is proposed. A specimen with an irregular growth pattern not clearly attributable to false annuli is rejected if it has a value of P for any increment below 40 or exceeding 120. This conservative rule can only increase the predictive reliability of the final model when it is applied to archaeological specimens.

Figure 4 shows an example of another type of aberration. This specimen shows an arrest mark on the outer edge of the section with a width already exceeding the entire previous year's growth. The reason for this aberration is unknown. This type of aberration was encountered in only one sample of fish (to be discussed).

The Regression.—The regression will serve as a model for predicting date of death for archaeological specimens. Figure 5 shows a plot of growth index by date of death for the 97 modern specimens. It is obvious that a simple linear function will not adequately describe these data. Moreover, the plot verifies an expected problem involving nonconstancy of the error variance without residual analysis. The error variance is expanding as the X term (date of death) increases. This sort of phenomenon is commonly encountered in time-related regression problems (cf. Neter and Wasserman 1974:101-104) and must be corrected since linear regression assumes constancy of the error variance.

Data transformations can often help stabilize non-constant error variance. The transformation applied here is based on Taylor's power law (Taylor 1961) which states

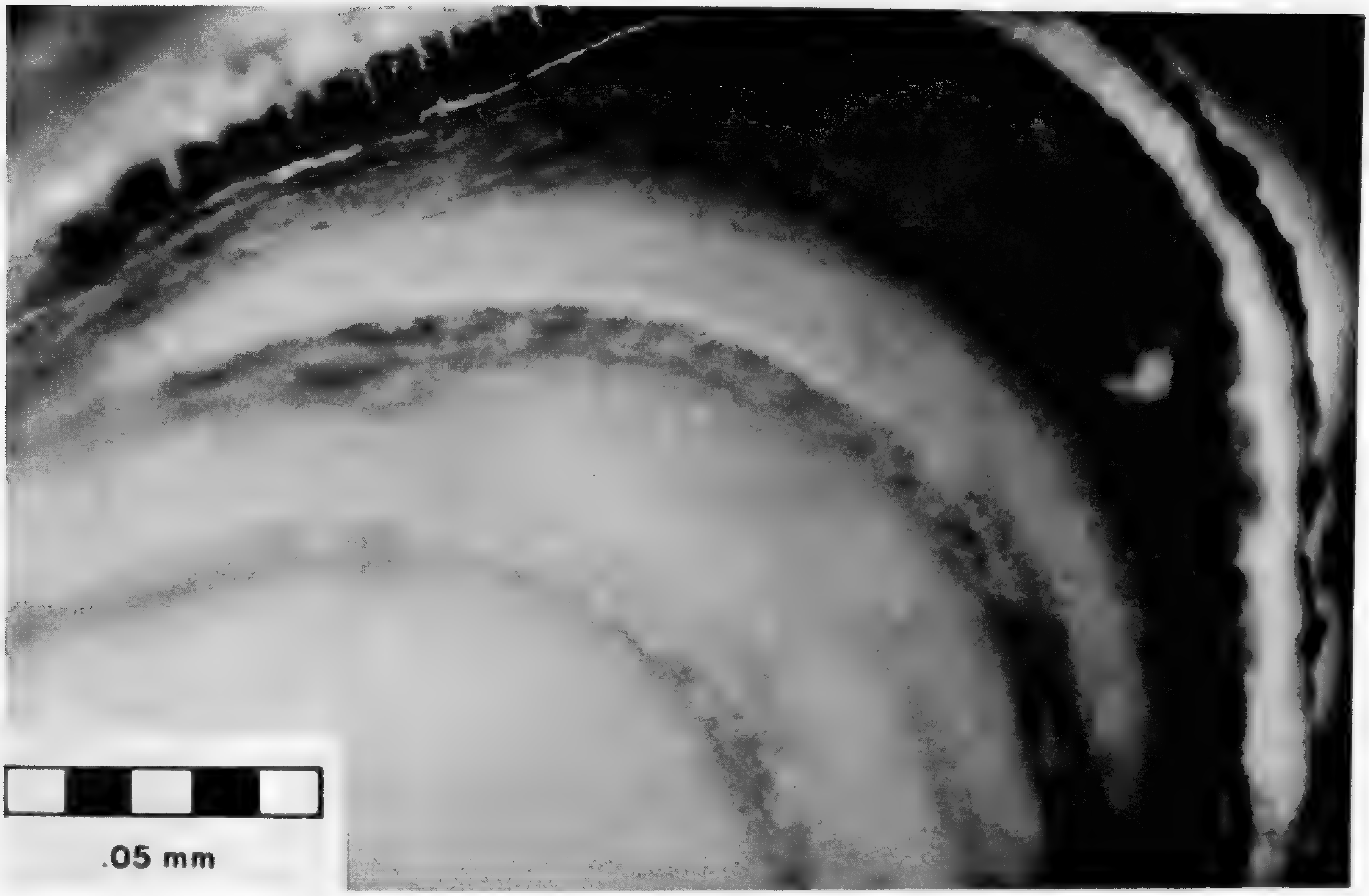


FIG. 4.–Photomicrograph of a rejected pectoral spine thin section from a Fort Loudoun Lake (Blount County, Tennessee) catfish that died on July 4, 1980.

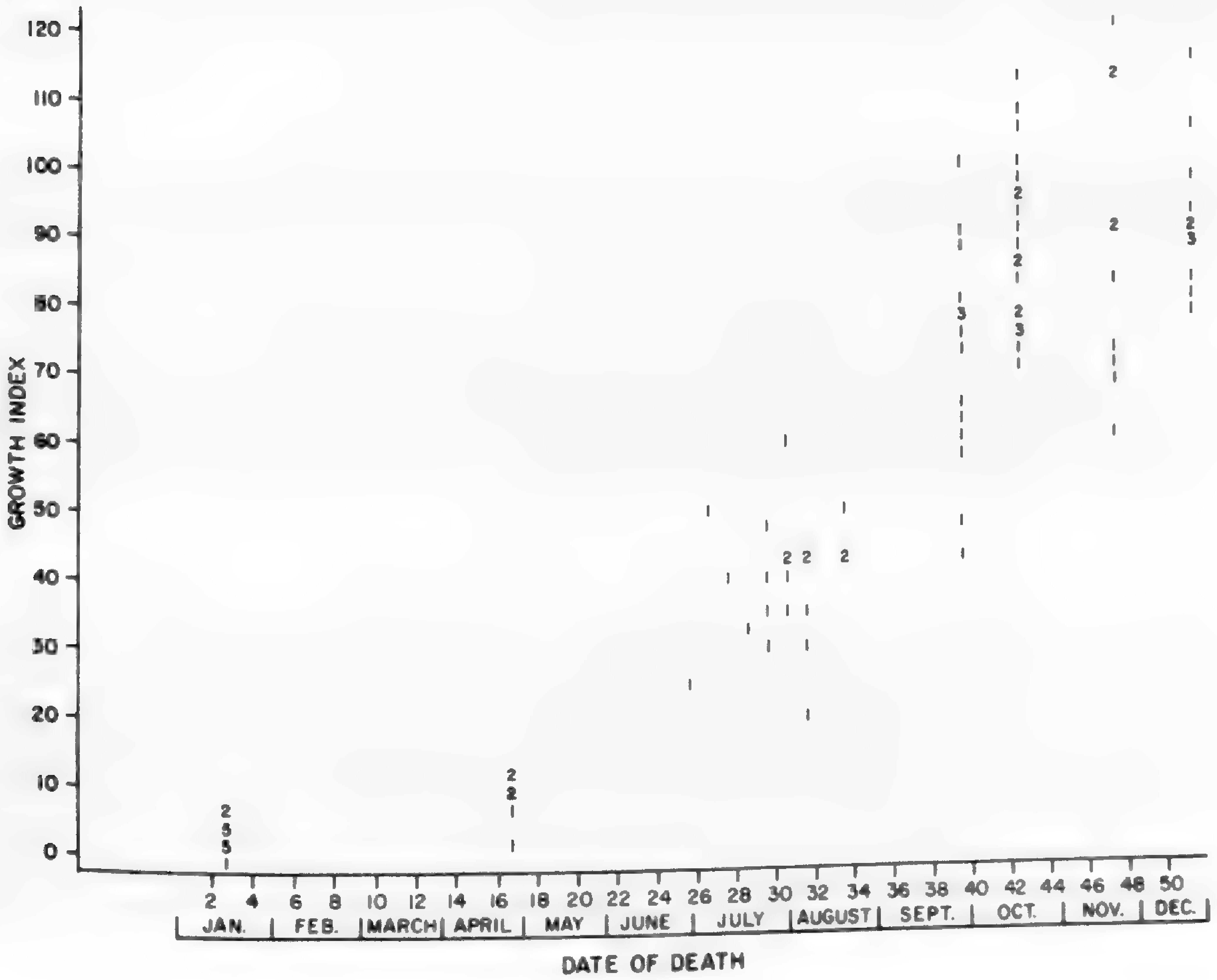


FIG. 5.–Plot of pectoral spine growth index by date of death for 97 modern channel catfish from the Middle South. 1 = one observation, 2 = two observations, etc.

that the variance of a population is proportional to a fractional power of the mean. The appropriate transformation is to raise each original observation (growth index) to the fractional power 1 - b/2, where b represents a slope coefficient (cf. Elliot 1977:71-73). The value of b is derived as follows. First the mean and variance of each discrete sample in the data set is obtained. Examination of Figure 5 shows six discrete (i.e. single date of death) samples from January, April, September, October, November and December. By pooling observations from a three week period in July (date of death 29-31) to obtain a much needed variance term from the scattered summer series, a seventh discrete sample is approximated. The seven mean and variance terms are then transformed to their common log values. The resulting terms are regressed (log variance by log mean) and a least squares line fit to the data. It is the slope coefficient from this regression that is needed. In the present case the slope coefficient is 1.274 which, when substituted for b (recall 1 - b/2), yields a value of .363. This value is the desired fractional power; when each original growth index is raised to the .363 power the results are as shown on Figure 6. This plot suggests that the error variance has been effectively stabilized, a preliminary evaluation confirmed by analysis of residuals after an appropriate analytical function has been fit (see below).

Though inconvenient, the desired function must be obtained with growth index treated as the Y (predicted) variable since it is measured with error. The alternative procedure will produce invalid results. There are two curves in the transformed data, suggesting that a third order polynomial might provide an appropriate curvilinear function. This is accomplished by squaring and cubing the X term (date of death) and adding the two new terms to a simple linear model. The form of the polynomial model is

$$Y = B_O + B_1X + B_2X^2 + B_3X^3$$

where B_O is the intercept and B_1, B_2 and B_3 are slope coefficients. Calculations for

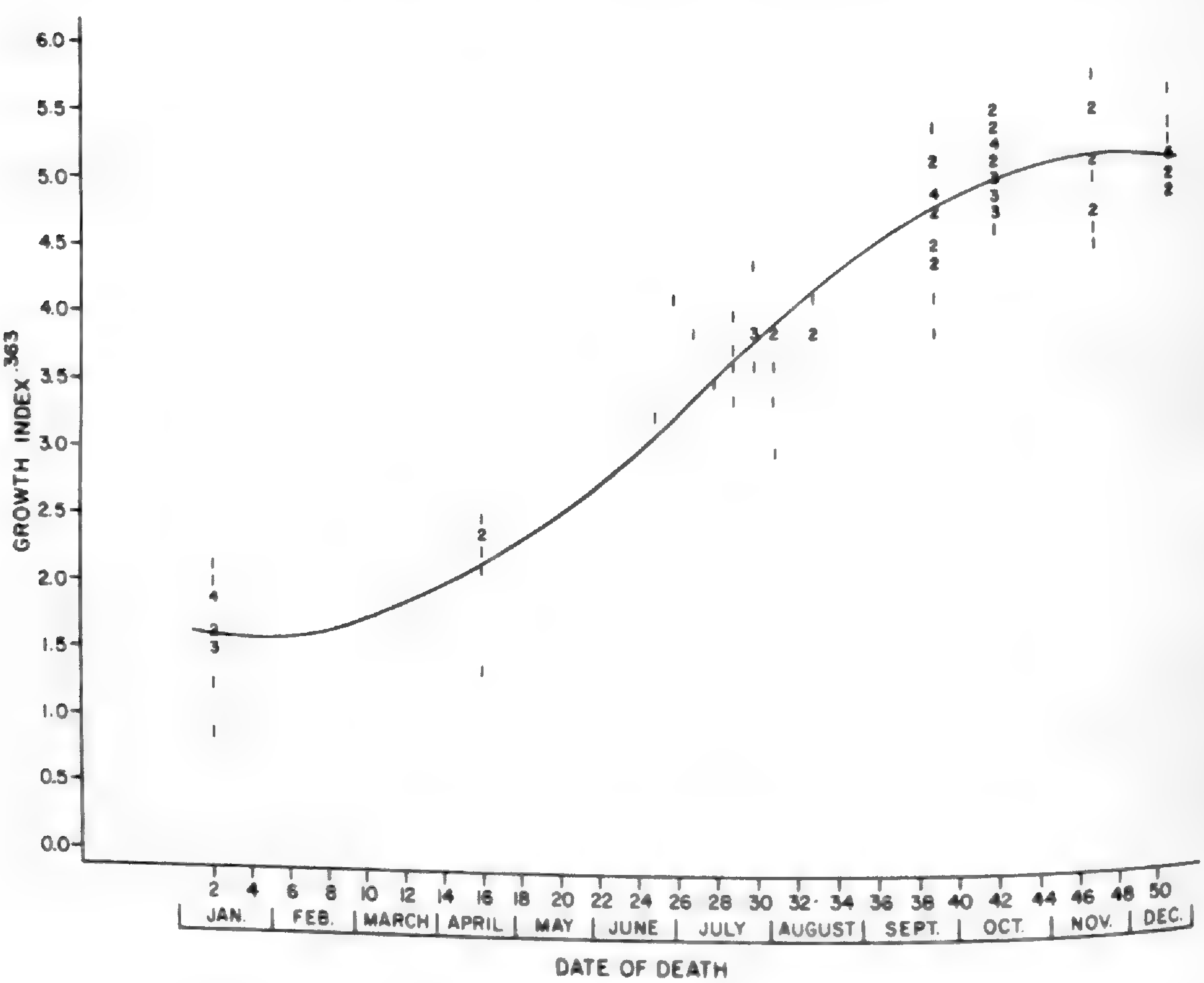


FIG. 6.–Plot of transformed pectoral spine growth index by date of death for 97 modern channel catfish from the Middle South. 1 = one observation, 2 = two observations, etc.

this regression were done at the University of Tennessee Computing Center, using SAS, PROC GLM (SAS Institute 1979).

Applying the above model to the transformed data yields positive results. F ratios indicate that all terms in the model are significant at the .05 level. Residual analysis (Fig. 7) indicates that the curve fits nicely; points are distributed approximately evenly on either side of the zero point axis with no pattern evident. Figure 7 should also be inspected with reference to the error variance problem. The R^2 coefficient of correlation between the two variables is .928.

The polynomial model fit to these data yields the following function:

$$Y = 1.74863 - .0583847X + .00678332X^2 - .0000851173X^3$$

The curve produced by this function is shown on Figure 6. It should now be evident why treating growth index as the predicted variable is inconvenient. To predict the date of death of an "unknown" specimen, a transformed growth index must be obtained and X solved for on the right-hand side of the equation. Fortunately, a less tedious procedre is available that produces the same results. Consider, first, that only whole number values of X from 1-52 are of interest. Using the polynomial to solve for all 52 values of X, 52 corresponding solutions for Y may be derived. This step has been taken, producing the results shown on Table 1. With this table it is possible to predict the date of death of "unknowns" without again referring to the polynomial equation. To accomplish this the transformed growth index of a given specimen is compared to the values of Y on Table 1 to determine which one is the closest. The value of X corresponding to this Y is the predicted date of death. This simple procedure yields the same results as deriving the tedious solution for the growth index and then rounding X to the nearest whole number.

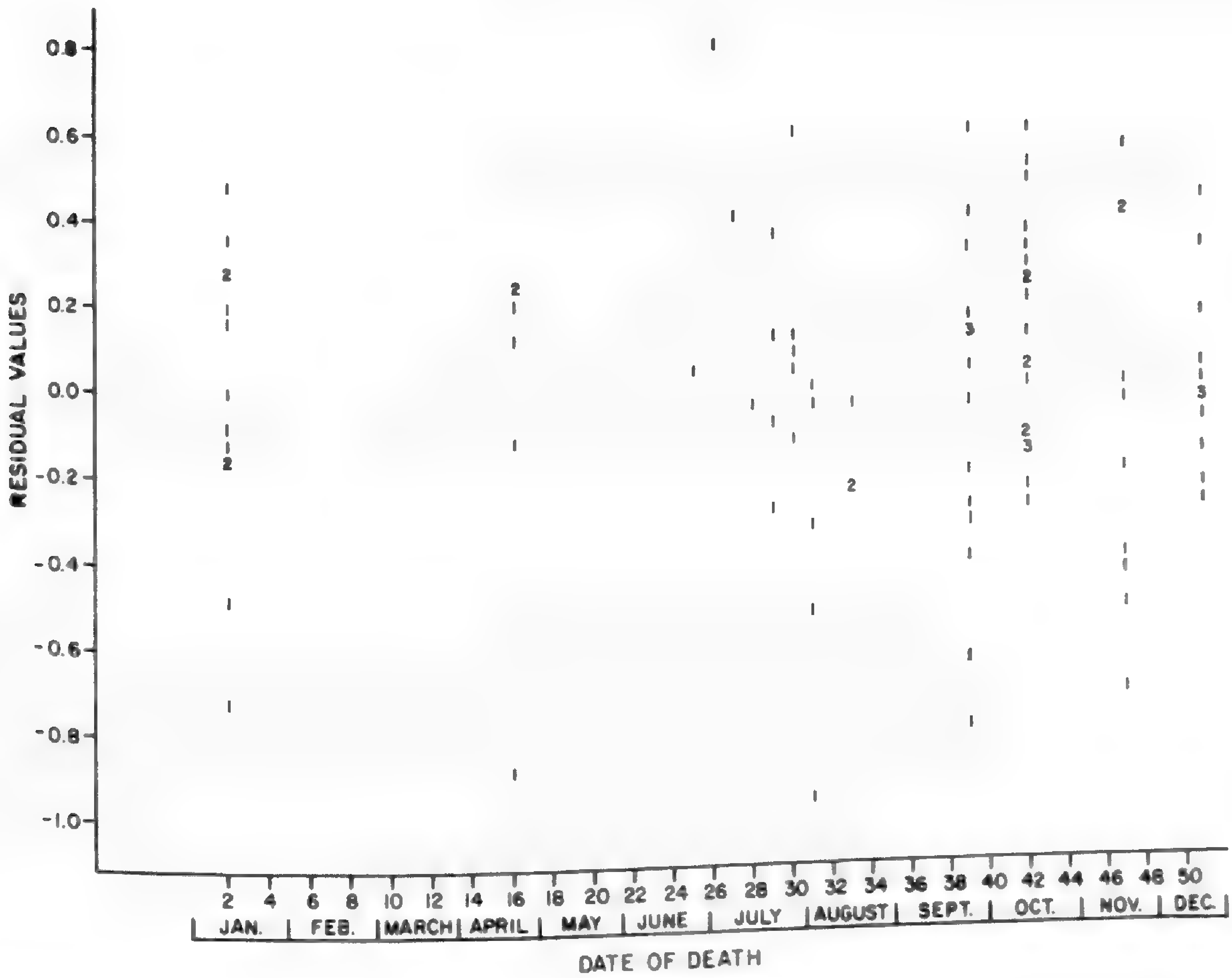


FIG. 7.–Plot of the residual values from the polynomial regression model by date of death. 1 = one observation, 2 = two observations, etc.

TABLE 1.—*Solutions for Y (growth index*$^{.363}$*) for every value of X (date of death, 1-52) based on the polynomial function.*

X (corresponding week)	Y	X (corresponding week)	Y
1 (Jan. 1-7)	1.69694	27 (July 2-8)	3.44191
2 (Jan. 8-14)	1.65831	28 (July 9-15)	3.56349
3 (Jan. 15-21)	1.63228	29 (July 16-22)	3.68430
4 (Jan. 22-28)	1.61818	30 (July 23-29)	3.80389
5 (Jan. 29-Feb. 4)	1.61565	31 (July 30-Aug. 5)	3.92173
6 (Feb. 5-11)	1.62413	32 (Aug. 6-12)	4.03730
7 (Feb. 12-18)	1.64312	33 (Aug. 13-19)	4.15009
8 (Feb. 19-25)	1.67211	34 (Aug. 20-26)	4.25959
		35 (Aug. 27-Sept. 2)	4.36531
any Y less than 1.70 is predicted as January-February		36 (Sept. 3-9)	4.46672
		37 (Sept. 10-16)	4.56329
		38 (Sept. 17-23)	4.65454
9 (Feb. 26-Mar. 4)	1.71056	39 (Sept. 24-30)	4.73997
10 (Mar. 5-11)	1.75799	40 (Oct. 1-7)	4.81902
11 (Mar. 12-18)	1.81388	41 (Oct. 8-14)	4.89122
12 (Mar. 19-25)	1.87773	42 (Oct. 15-21)	4.95605
13 (Mar. 26-Apr. 1)	1.94902	43 (Oct. 22-28)	5.01299
14 (Apr. 2-8)	2.02722	44 (Oct. 29-Nov. 4)	5.06155
15 (Apr. 9-15)	2.11184		
16 (Apr. 16-22)	2.20235	any Y greater than 5.07 is predicted as November-December	
17 (Apr. 23-29)	2.29829		
18 (Apr. 30-May 6)	2.39909		
19 (May 7-13)	2.50429	45 (Nov. 5-11)	5.10119
20 (May 14-20)	2.61332	46 (Nov. 12-18)	5.13143
21 (May 21-27)	2.72571	47 (Nov. 19-25)	5.15173
22 (May 28-June 3)	2.84097	48 (Nov. 26-Dec. 2)	5.16160
23 (June 4-10)	2.95853	49 (Dec. 3-9)	5.16052
24 (June 11-17)	3.07992	50 (Dec. 10-16)	5.14799
25 (June 18-24)	3.19862	51 (Dec. 17-23)	5.12348
26 (June 25-July 1)	3.32013	52 (Dec. 24-31)	5.08649

Table 1 also allows further assessment of the aptness of the polynomial model. The 52 solutions of Y for X yield 52 coordinates for the curve fit to the data on Figure 6. Table 1 and Figure 6 show that the curve is literally going backwards during the first four weeks and then again during the last four weeks. Interpreted literally, Table 1 and Figure 6 indicate that as the date of death increases the growth index gets smaller during the first four weeks of the year and then again during the last four weeks. In both cases these are misfits of no real significance. First, the magnitude of the errors is very small. Second, from inspection of Figure 6 it is clear that there is decreased predictive resolution during these periods. The misfits both encompass eight weeks; therefore, summary rules of evaluation for these periods appear at the appropriate junctures on Table 1. No accuracy has been sacrificed.

A complication potentially affecting the predictive reliability of the model can be detected by comparing Figure 5 with previously presented data on the variable P. Data on P suggest that fish who have completed their yearly growth but do not show evidence of annulus formation should tend to produce a growth index in the range of about 75-85. Yet, from Figure 5 it is apparent that the late fall/early winter samples (mid-October, mid-November, mid-December) produced growth indices tending to fall above this range. The mean growth index for each of these samples is 87.87, 91.006 and 91.04, respectively. These three samples are from the same year (1981) and from the same general location from the Tennessee River in Middle Tennessee. The year 1981 was evidently an exceptionally "good" year for growth among catfish in this portion of the Tennessee River.

From the above discussion it is reasonable to suspect that "unknowns" that died during the late fall will tend to be slightly underpredicted. However, this problem is minimized by the polynomial function. From the residual plot (Fig. 7) it can be seen that approximately two-thirds of the mid-October observations fall above the curve, indicating that the specific fit of the curve will help compensate for this source of error. For example, if a specimen with a growth index equal to the mean of the mid-October sample (87.87) is evaluated, it will be more accurately predicted in the November-December range. Any fish with a growth index in the range of 75-85 will be predicted as October, which is entirely rational based on analysis of the variable P. It must be borne in mind, however, that fish with a growth index in the range of 75-85 could have died in November or perhaps December.

More importantly, it must be realized that there is always decreased predictive resolution during periods of decelerated growth. Data presented here suggest that weekly predictions in the mid-October to mid-April range must always be evaluated cautiously. The empirical distinction between fish with a high growth index (75+) and fish showing the initial stage of annulus formation allows reliable separation between late fall/early winter and late winter/early spring fish. However, specific weekly predictions during these periods are undoubtedly subject to substantial error. For this reason the summary rules of evaluation for November-December and January-February estimates (Table 1) are especially useful since they encompass that period of the year when confusion is most likely.

Overall, this procedure provides an efficient predictive tool. There is no danger of misleading extrapolation beyond the range of the data set, a common problem with polynomial regression (cf. Neter and Wasserman 1974:275). By definition, X has a finite range; it can never be less than 1 or exceed 52. The summary rules of evaluation on Table 1 prevent mathematically feasible but logically impossible predictions outside this range.

A Test of Validity.—The only real test of this methodological tool is whether or not it works. This cannot be assessed with archaeological specimens since it is impossible to know the true date of death. However, tests can be conducted on modern specimens. To do this 17 pectoral spines from 17 modern channel catfish with known dates of death were evaluated. However, this was a "blind" test; the dates of death were unknown to me at the time of evaluation. All 17 specimens are from the impounded Tennessee River in Blount County, east Tennessee, a source different than any in the regression series.

Nine of the 17 specimens were immediately rejected. Figure 5 shows one of these rejected specimens. This fish, with abnormally wide annuli, died on July 4 and would be predicted incorrectly by several months. Six additional specimens showed a similar abnormality. Two more had annuli too indistinct to permit reliable measurements. Table 2 summarizes results on the remaining eight. One specimen (LL-108) was missed completely. It showed no significant irregularity, had developed an arrest mark on the outer edge, and was measured accordingly. The arrest mark was evidently non-annual. Unfortunately, when such specimens occasionally do occur, an unavoidable risk of significant error results. Predictions on the remaining seven are relatively close; all are predicted correctly to general season, five within one month. Age at death of the eight fish represented ranges from two to seven years and there is no apparent correlation between age and accuracy of prediction.

Two important points emerge from this test. First, the procedure works; seven of eight specimens show a good correlation between predicted and actual date of death. Second, knowing when to reject specimens is as important as knowing how to measure them.

TABLE 2.—*Comparison of regression-based predicted week of death and actual date of death of eight channel catfish from Fort Loudoun Lake, Blount County, Tennessee, based on pectoral spines.*

Specimen	Growth Index	Growth Index$^{.363}$	Predicted Week	Actual Date of Death	Error
LL-108	5.79	1.8917	March 19-25	September 12, 1978	6 months
LL-154	29.03	3.39636	July 2-8	June 9, 1980	+3-4 weeks
LL-156	52.50	4.21132	August 20-26	June 8, 1980	+6-7 weeks
LL-158	31.25	3.48843	July 2-8	June 9, 1980	+3-4 weeks
LL-159	7.27	2.05465	April 2-8	April 21, 1980	–2-3 weeks
LL-160	9.42	2.25725	April 23-29	April 21, 1979	+0-1 week
LL-162	54.05	4.25603	August 20-26	June 9, 1980	+10-11 weeks
LL-163	18.35	2.87541	May 28-June 3	June 9, 1980	+1-2 weeks

Additional Tests on Modern Specimens.—Because this procedure will have application outside the Middle South it is desirable to explore the possible effects of latitude on its predictive accuracy. Two additional series of modern catfish spines were obtained, one from the Sangamon River drainage in Cass and Mason counties, west-central Illinois, and the other from the Missouri River on the Nebraska-South Dakota border. All specimens were five years old or less when they died and the date of death was known when they were evaluated.

Tables 3 and 4 summarize results of these tests. The correlation between predicted and actual dates of death is good. The reader should note that six of these specimens (Table 3) are black bullhead *(Ictalurus melas)* rather than channel catfish *(I. punctatus)*. Overall, the bullheads were predicted as accurately as the channel catfish. Since all fish in the Illinois series died within three days of each other, Table 3 presents an evaluation based on the mean growth index. The error factor associated with this group prediction (−1-2 weeks) is very small. Nine of the 11 specimens were underpredicted; the error factor associated with the group prediction might be larger if not for the remaining two specimens which were overpredicted by surprisingly high margins considering the tendency of the other nine to be underpredicted. Overall, this test suggests that evaluating fish from about 350 km north of the Tennessee/southern Kentucky region may introduce a tendency toward underprediction.

Moving farther north, the tendency toward underprediction with the Missouri River series (Table 4) is more pronounced. The correlation between underprediction and more northerly latitude makes intuitive sense. It is likely that fish in this region start their yearly growth cycle later than fish in the Middle South since winter (i.e. lower temperatures) lasts longer. According to Weatherly and Rogers (1978:67), "Growth is 'released' in fish at various species-specific threshold temperatures below which it cannot occur and above which an optimum will be located." Whatever the threshold temperature is for catfish, it is surely reached sooner in the spring in Middle South waters than in more northerly waters.

Evaluations on four of the eight specimens on Table 4 are based on dorsal rather than pectoral spines. Dorsal spines were the only bones available from these specimens and it is assumed that their seasonal growth is similar to that of pectoral spines. Like pectoral spines, they were sectioned near the base and measured on the posterior portion of the sections.

Results of the above tests suggest a tendency toward underprediction with increasingly northerly latitude. Modest correction factors for specimens from Nebraska (see below) are considered reasonable, though tentative.

AN ARCHAEOLOGICAL APPLICATION FROM CENTRAL NEBRASKA

The Schmidt site (25HW301), which represents a late prehistoric horticultural settlement, is located on a terrace overlooking the North Loup River in central Nebraska. The site clearly falls within the Central Plains Tradition (cf. Brown 1966; Krause 1969; Lehmer 1971:99-105; Blakeslee 1978) and has been tentatively assigned to the Loup River phase (Ludwickson 1978). The Loup River phase is a taxon which some investigators (e.g. Ludwickson 1978) believe represents lineal antecedents of the historic Pawnee. Intermittent excavations conducted at the Schmidt site from 1976 to 1978 by crews from the University of Nebraska-Lincoln and local amateurs yielded an abundance of well preserved faunal remains from eight house structures and 22 associated major features.

The Schmidt site was the object of a study of subsistence and seasonality among horticulturalists in the Central Plains[3] (Morey 1982). In this study ethnohistoric information on the Pawnee, Omaha and Ponca Indians was consulted as a source of ideas bearing on the seasonality of the Schmidt site. Information on the seasonal subsistence activities of these groups was integrated into a model of subsistence and seasonality among Central Plains villagers. The model specifies fall and spring village occupation with

TABLE 3.—*Comparison of regression-based predicted week of death and actual date of death of eleven channel catfish (Ictalurus punctatus) and black bullheads (Ictalurus melas) from the Lower Sangamon River drainage in Cass and Mason counties, Illinois, based on pectoral spines.*

Specimen/Species	Growth Index$^{.363}$	Predicted Week	Actual Date of Death	Error
LSD-11-16/*I. punctatus*	4.35792	Aug. 27-Sept. 2	September 7, 1971	–1-2 weeks
LSD-11-11/*I. punctatus*	4.33918	Aug. 27-Sept. 2	September 7, 1971	–1-2 weeks
LSD-11-9/*I. punctatus*	4.38329	Aug. 27-Sept. 2	September 7, 1971	–1-2 weeks
LSD-11-4/*I. punctatus*	4.01878	Aug. 6-12	September 7, 1971	–4-5 weeks
LSD-11-8/*I. punctatus*	3.65071	July 16-22	September 7, 1971	–7-8 weeks
LSD-17-2/*I. melas*	4.42047	Sept. 3-9	September 10, 1971	–0-1 week
LSD-17-3/*I. melas*	4.31812	Aug. 27-Sept. 2	September 10, 1971	–1-2 weeks
LSD-17-4/*I. melas*	4.35792	Aug. 27-Sept. 2	September 10, 1971	–1-2 weeks
LSD-11-2/*I. melas*	4.91262	Oct. 8-14	September 7, 1971	+5-6 weeks
LSD-17-5/*I. melas*	4.06695	Aug. 6-12	September 10, 1971	–4-5 weeks
LSD-17-1/*I. melas*	5.32108	Nov.-Dec.	September 10, 1971	+7-16 weeks
Mean Evaluation	4.41261	Aug. 27-Sept. 2	September 7-10, 1971	–1-2 weeks

TABLE 4.–*Comparison of regression-based predicted week of death and actual date of death of eight channel catfish from the Missouri River along the Nebraska-South Dakota border, based on pectoral and dorsal spines.*

Specimen/Spine	Growth Index$^{.363}$	Predicted Week	Actual Date of Death	Error
SUSD-72-1/pectoral	4.46396	Sept. 3-9	September 16, 1972	–1-2 weeks
SUSD-72-2/pectoral	4.96436	Oct. 15-21	October 10, 1972	+1-2 weeks
SUSD-72-3/pectoral	3.95824	July 30-Aug. 5	September 16, 1972	–6-7 weeks
SUSD-72-4/pectoral	3.72206	July 16-22	September 16, 1972	–8-9 weeks
SDFR-66-2/dorsal	3.01081	June 11-17	July 13, 1966	–4-5 weeks
SDFR-66-1/dorsal	3.09629	June 11-17	July 13, 1966	–4-5 weeks
SDFR-66-4/dorsal	3.0686	June 11-17	July 13, 1966	–4-5 weeks
SDFR-66-5/dorsal	3.53252	July 9-15	July 13, 1966	

complete abandonment for communal bison hunts during the winter and summer. The modeled seasonal pattern is believed to have had its roots well back into precontact times in spite of the various effects of Euro-American contact, including the introduction of the horse.

The long term stability of the modeled seasonal pattern resulted because Central Plains villagers, both prehistoric and historic, responded to similar environmental circumstances. Specifically, a restricted growing season of 100 to 140 days during most years resulted in a high level of dependence on food storage strategies among these groups, a circumstance which favored extended communal bison hunts during summer and winter (Morey 1982:60-66). Prehistoric Central Plains horticulturalists were surely no less affected by the restricted growing season and procurement requirements of bison, the critical animal food resource in this region. Therefore, it was proposed that seasonal evidence from the Schmidt site should indicate that it was occupied only during the spring (April-late June) and fall (September-October) (Morey 1982:66).

Seasonal Evidence from the Schmidt Site.—The major source of seasonal evidence from the Schmidt site is a series of catfish pectoral spines from several provenience units. Archaeological catfish spines are embedded in epoxy prior to sectioning; otherwise, preparation is identical to that of modern specimens. The rejection rate on archaeological specimens is similar to that of most modern samples (15-20%) if none are burned; burned specimens are presently unanalyzable. Figure 8 shows an archaeological spine section from a Schmidt site specimen in which the arrest lines, which are clearly visible, are identified.

The most useful series of spines from the Schmidt site are 15 specimens from the second arbitrary level (15 cm) of a large undercut pit. At least eight individuals are represented; they are tentatively identified as *Ictalurus melas* (black bullhead). All 15 spines are from fish three years old or less when they died. Table 5 summarizes results of evaluation of these specimens. The estimates clearly cluster in the late April-May-June range. Several lines of evidence suggest that it is reasonable to assume that a single procurement episode, perhaps a single day, is represented. They are all from a single arbit-

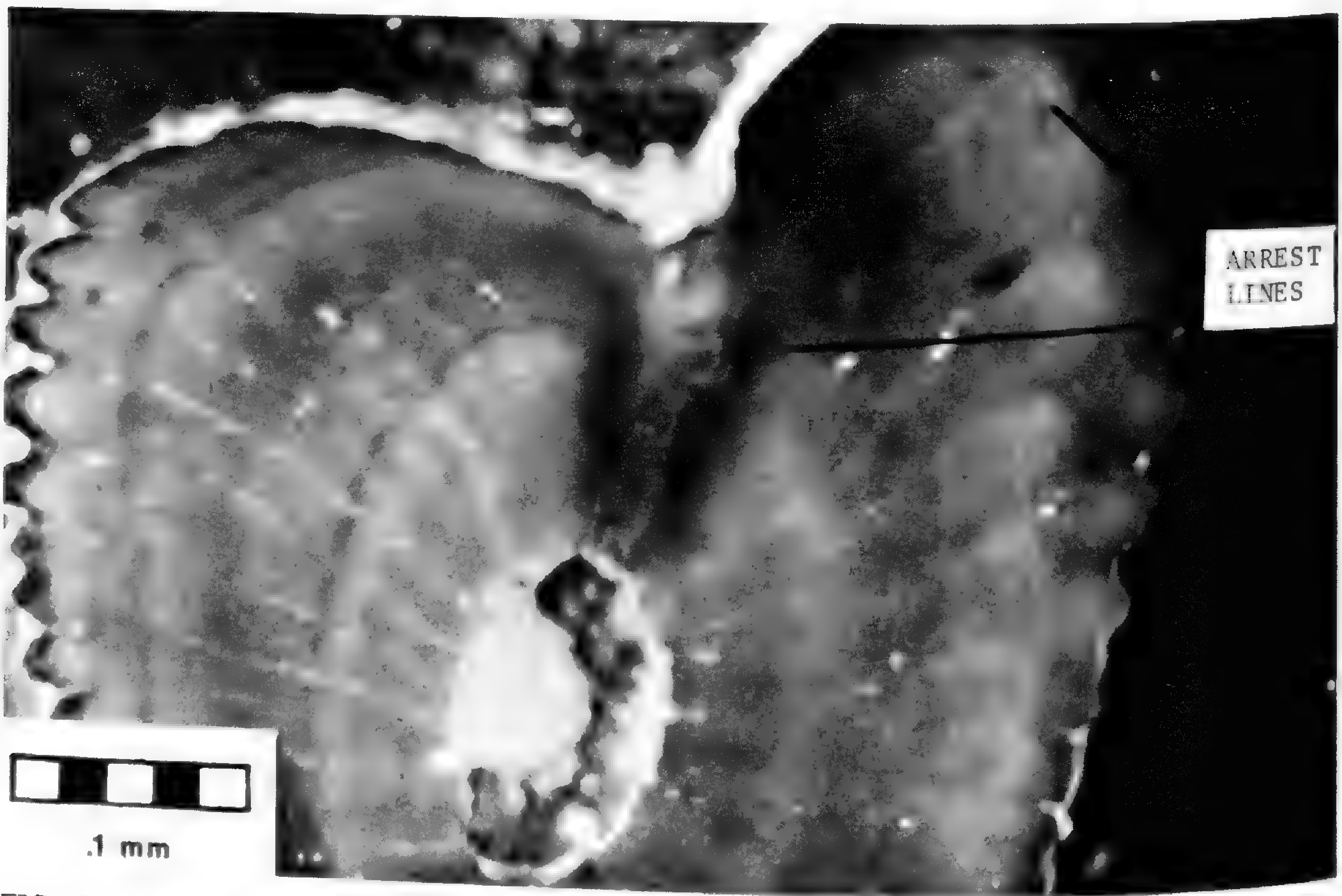


FIG. 8.—Photomicrograph of a thin section from a Schmidt site catfish pectoral spine (specimen 207-1).

rary level of a feature, are of uniformly small size, and their state of preservation is identical. Moreover, the unimodal distribution of predicted dates of death supports this assumption. Therefore, Table 5 includes an evaluation based on the mean growth index of the series that yielded a predicted week of death of May 21-27. For a series from this latitude, falling early in the year, a correction factor of adding 1-2 weeks is tentatively suggested. This places the series squarely in the first half of June.

Several other provenience units yielded five isolated spines that were measureable. Age at death was four years old or less for all five specimens. Table 6 summarizes results

TABLE 5.–*Regression-based predicted week of death for 15 bullhead (Ictalurus cf. melas) pectoral spines from a single arbitrary level (15 cm.) of a large undercut pit at the Schmidt site.*

Specimen	Growth Index	Growth Index$^{.363}$	Predicted Week
282-1	12.22	2.48089	May 7-13
282-2	11.11	2.39659	April 30-May 6
282-4	13.95	2.60304	May 14-20
282-6	22.50	3.09629	June 11-17
282-7	10.14	2.31842	April 23-29
282-8	25.0	3.21701	June 18-24
282-9	18.88	2.90528	May 28-June 3
282-10	29.03	3.39636	July 2-8
282-11	7.34	2.06181	April 2-8
282-12	13.04	2.54007	May 7-13
282-13	14.14	2.61585	May 14-20
282-16	23.08	3.12503	June 11-17
282-17	11.30	2.41139	April 30-May 6
282-18	10.71	2.3649	April 30-May 6
282-19	27.63	3.33596	June 25-July 1
Mean Evaluation	16.67	2.77699	May 21-27

TABLE 6.–*Regression-based predicted week of death for five catfish (Ictalurus sp.) pectoral spines from several provenience units at the Schmidt site.**

Specimen	Growth Index	Growth Index$^{.363}$	Predicted Week
96-1	66.67	4.5929	Sept. 10-16
17-1	60.78	4.44125	Sept. 3-9
207-1	46.48	4.02919	August 6-12
290-1	48.15	4.08115	August 6-12
290-2	51.11	4.17049	August 13-19

*Specimens 96-1, 17-1 and 207-1 were recovered from three different large undercut pits at the Schmidt site – see text for explanation of specimens 290-1 and 290-2.

of evaluation of these specimens. The estimates clearly fall in the late summer/early fall range. Correction factors of + 2-3 weeks for the mid-August estimates and + 1-2 weeks for the September estimates are tentatively suggested. This places estimates on two specimens (96-1 and 17-1) in late September and estimates on the remaining three during late August/early September.

Specimens 290-1 and 290-2 are problematical in that they are from the third level of the same feature as the previously described series of 15 specimens. However, field notes on file at the Department of Anthropology, University of Nebraska-Lincoln provide evidence of a stratigraphic separation between levels 2 and 3. Level 1-2 fill was evidently looser and less compact than level 3 fill. In any case, predictions on the level 3 specimens are inconsistent with predictions on the level 2 series and it is assumed that a different procurement episode is represented.

It is assumed that Middle South catfish start their yearly growth slightly earlier than Central Plains catfish. Yet, it is also reasonable to assume that the average value of P from spines of Middle South and Central Plains catfish is the same, leading to the conclusion that Central Plains catfish must have a slightly more rapid growth rate than Middle South catfish at some point, probably during mid- to late summer. Perhaps the average temperature of Middle South waters during this period exceeds the optimum for catfish growth (cf. Weatherly and Rogers 1978:67). Moreover, there is no evidence that suggests the overall growth rate of catfish varies systematically between different regions in North America (Carlander 1969:550). Therefore, it is likely that predictive error between the two regions will be greatest during mid-summer (July to mid-August) when Central Plains catfish are "catching up" in growth. Error should be least pronounced in spring and fall. This is the reason for variation in the suggested correction factors for Schmidt site specimens. It should be emphasized that the proposed correction factors are tentative estimates with no statistical basis; they are considered subject to amendment if additional data suggest that this is warranted.

SUMMARY AND CONCLUSION

This paper has presented a reliable, replicable procedure for archaeological assessment of seasonality from freshwater catfish remains based on analysis of incremental growth structures in pectoral spines of modern channel catfish. The reliability of the procedure was assessed with a "blind" test on modern specimens. Tests on modern specimens from locations north of the Middle South suggest that patterned predictive error results when such specimens are evaluated.

Although there are potential problems with any archaeological seasonality study (cf. Monks 1981) evaluation of archaeological catfish spines provided the most reliable evidence bearing on the seasonal occupation of the Schmidt site. As predicted, analysis of Schmidt site catfish spines suggests, minimally, fall and spring occupation on the site. Moreover, other traditional lines of seasonal evidence, though more tenuous, are consistent with evidence from the catfish spine analysis. Specifically, age-at-death estimates on deer and bison mandibles based on tooth eruption and wear schedules and inferred periods of maximum availability of several groups of migratory birds represented at the Schmidt site suggest fall and spring occupation (Morey 1982:128-133). All evidence considered compares favorably with a model of seasonal site occupation in the Central Plains generated from ethnohistoric information (Morey 1982). It is true, of course, that an argument for *only* fall and spring occupation of the Schmidt site requires an appeal to negative evidence. Additional sources of seasonal information, if available, might suggest summer and/or winter occupation. Thus, an important task facing archaeologists interested in the reconstruction of settlement-subsistence systems is to develop additional methodological tools for assessing archaeological site seasonality.

ACKNOWLEDGEMENTS

Research reported here was conducted as part of my M.A. program at The University of Tennessee-Knoxville, Department of Anthropology. The members of my thesis committee—Drs. Paul W. Parmalee (chairman), Walter E. Klippel, Gerald F. Schroedl and Carl R. Falk—all made substantive contributions to this research in different but complementary ways. Drs. Walter E. Klippel and Paul W. Parmalee read an earlier draft of this paper and offered many useful comments. Terry Faulkner and Sally Donovan provided the illustrations.

Field work was conducted at the Schmidt site by both amateurs and professionals intermittently from 1976-1978. Professional work was undertaken by crews from the University of Nebraska-Lincoln with support from a grant provided by the University of Nebraska Happhold Foundation. Field work was directed by Steve Holen under the overall supervision of Dr. Peter Bleed and Carl R. Falk. The site is on land owned by Anton Schmidt, whose generous hospitality to the various field crews is gratefully acknowledged. My sincere appreciation goes to all those individuals who participated in the Schmidt project at various times.

This research would not exist without the help of the following individuals who helped me collect modern catfish: D. Amick, C. Hall, J. Hofman, P. Hofman, Dr. W. Klippel, D. Klippel, R. Klippel, B. Manzano, Dr. P.W. Parmalee, M. Smith, D. Turner and W. Turner. I also gratefully acknowledge Kenneth Brown, Carl Falk and Walter Klippel, who provided modern specimens from their personal or institutional collections. Most of the fall samples were originally collected by commercial fishermen working on the Tennessee River near Perryville, Tennessee. I obtained these samples through the courtesy of Earl Ray "Sarge" Westmoreland and Dock Maxwell at Sarge's Restaurant in Culleoka, Tennessee. Several individuals provided help with the actual analysis. Steve Symes and Bruce Manzano provided instruction and advice on the use of equipment in the thin sectioning laboratory. I am grateful to Dr. Neil Greenberg for the use of photomicrographic equipment at The University of Tennessee Department of Zoology. I am also indebted to Drs. Gregory Morey-Gaines (Department of Botany, University of Southern Illinois-Carbondale) and Donald J. Wheeler (Department of Statistics, The University of Tennessee) for their helpful advice on the statistical portion of this study. Special thanks go to Dr. Walter Klippel for his enthusiastic support of this research.

I am, of course, solely responsible for the contents of this paper.

LITERATURE CITED

ADAIR, M.J. 1977. Subsistence exploitation at the Young site. Unpubl. M.A. thesis, (Anth.), Univ. Kansas, Lawrence.

APPELGET, J. and L. L. SMITH. 1951. The determination of age and rate of growth from vertebrae of the channel catfish, *Ictalurus lacustris punctatus.* Trans. Amer. Fish. Soc. 80:119-139.

ARKIN, H. and R. R. COLTON. 1963. Tables for Statisticians. Barnes and Noble, New York.

ARTZ, J. A. 1980. Inferring season of occupation from fish scales: an archeological approach. Plains Anthrop. 25(87):47-61.

ATEN, L. E. 1981. Determining seasonality of *Rangia cuneata* from Gulf Coast shell middens. Bull. Texas Arch. Soc. 52:179-200.

BAGENAL, T. B. and F. W. TESCH. 1978. Age and growth. Pp. 101-136, *in* Methods for Assessment of Fish Production in Fresh Waters (T. B. Bagenal, ed.), Blackwell Scientific Publ., Oxford.

BENN, D. W. 1974. Annuli in the dental cementum of white-tailed deer from archeological contexts. Wisconsin Arch. 55(2): 90-98.

BLAKESLEE, D. J. (editor). 1978. The Central Plains Tradition: internal stability and external relationships. Univ. Iowa, Office of the State Archaeologist, Report 11.

BOURQUE, B. J., K. MORRIS and A. SPIESS. 1978. Determining season of death of mammal teeth from archaeological sites. Science 199:530-531.

BOZELL, J. R. 1981. Middle and late Woodland vertebrate resource use in northeast Missouri. Unpubl. M.A. thesis (Anth.), Univ. Nebraska, Lincoln.

BROWN, L. 1966. Temporal and spatial order in the Central Plains. Plains Anthrop. 11(34): 294-301.

CALOVICH, F. E. and B. A. BRANSON. 1964. The supra-ethmoid complex in the American catfishes, *Ictalurus* and *Pylodictis.* Amer. Mid. Natur. 71(2):335-343.

CARLANDER, K. D. 1969. Handbook of Freshwater Fishery Biology Vol. 1 (third edition). Iowa State Univ. Press, Ames.

CASTEEL, R. W. 1972. Some archaeological uses of fish remains. Amer. Antiquity 37(3): 404-419.

__________. 1976. Fish Remains in Archaeology. Acad. Press, New York and London.

COUTTS, P. J. F. 1970. Bivalve growth patterning as a method for seasonal dating in archaeology. Nature 226:874.

COUTTS, P. J. F. and C. F. W. HIGHAM. 1971. The seasonal factor in prehistoric New Zealand. World Arch. 2:266-277.

COUTTS, P. J. F. and K. L. JONES. 1974.

LITERATURE CITED (continued)

A proposed method for deriving seasonal data from the echinoid, *Evechinus chloroticus* (Val.), in archaeological deposits. Amer. Antiquity 39(1):98-102.

ELLIOT, J. M. 1977. Some methods for the statistical analysis of samples of benthic invertebrates (second edition). Freshwater Biol. Assoc., Scientific Pub. 25.

FORNEY, J L. 1955. Life history of the black bullhead, *Ameiurus melas* (Rafinesque), of Clear Lake, Iowa. Iowa State College J. Science 30(1):145-162.

FRISON, G. C. 1978. Animal population studies and cultural inference. Plains Anthrop. Memoir 14:44-52.

FRISON, G. C. and C. A. REHER. 1970. Age determination of buffalo by teeth eruption and wear. Plains Anthrop. Memoir 7:46-50.

GRIZZLE, J. M. and W. A. ROGERS. 1976. Anatomy and histology of the channel catfish. Report of the Auburn Univ. Agric. Exper. Station (n.s.), Auburn, Alabama.

HAM, L. C. and M. IRVINE. 1975. Techniques for determining seasonality of shell middens from marine mollusc remains. Syesis 8: 363-373.

JENKINS, R. M. 1956. Growth of blue catfish *(Ictalurus furcatus)* in Lake Texoma. Southwestern Natur. 1(4):166-173.

KAY, M. 1974. Dental annuli age determination on white-tailed deer from archaeological sites. Plains Anthrop. 19:224-227.

KRAUSE, J. D. 1977. Identification, cultural and ecological implications of catfish remains from Cahokia Mounds, Illinois. Unpubl. M.S. thesis (Biol.), Univ. Southern Illinois, Edwardsville.

KRAUSE, R.A. 1969. Correlation of phases in Central Plains prehistory. Plains Anthrop. Memoir 6:82-96.

LAGLER, K. F. 1956. Freshwater Fishery Biology (second edition). Brown, Dubuque, Iowa.

LEHMER, D. J. 1971. Introduction to Middle Missouri archeology. Natl. Park Service, Anthrop. Papers 1.

LEWIS, W. M. 1949. The use of vertebrae as indicators of the age of the northern black bullhead *(Ameiurus m. melas)* (Rafinesque). Iowa State College J. Science 23:209-218.

LIPPINCOTT, K. A. 1976. Settlement ecology of Solomon River Upper Republican sites in north-central Kansas. Unpubl. Ph.D. dissert. (Anth.), Univ. Missouri, Columbia.

LUDWICKSON, J. 1978. Central Plains Tradition settlements in the Loup River basin: the Loup River phase. Pp. 94-108, *in* The Central Plains Tradition: internal stability and external relationships (D. J. Blakeslee, ed.), Univ. Iowa, Office of the State Archaeologist, Report 11.

MARZOLF, R. C. 1955. Use of pectoral spines and vertebrae for determining age and rate of growth of the channel catfish. J. Wildlife Management 19(2):243-249.

MONK, S. M. and J. R. BOZELL. 1980. Utilizing dental annuli as an indicator of age and seasonality for archeological vertebrae fauna. Univ. Nebraska, Div. Arch. Res., Tech. Report 80-27.

MONKS, G. 1981. Seasonality studies. Pp. 177-240, *in* Advances in Archaeological Method and Theory Vol. 4 (M. B. Schiffer, ed.), Acad. Press, New York and London.

MOREY, D. F. 1981. Archeological assessment of seasonality from catfish pectoral spines. Paper presented at the 39th Plains Anthrop. Conf., Bismarck, North Dakota, October, 1981.

———. 1982. A study of subsistence and seasonality in the Central Plains. Univ. Nebraska, Div. Arch. Res., Tech. Report 82-12.

MUNDELL, R. L. 1975. An illustrated osteology of the channel catfish *(Ictalurus punctatus)*. Natl. Park Service, Midwest Arch. Center, Report 2. Lincoln, Nebraska.

NETER, J. and W. WASSERMAN. 1974. Applied Linear Statistical Models. Richard D. Irwin, Homewood, Illinois.

PALOUMPIS, A. A. 1963. A key to the Illinois species of *Ictalurus* (Class Pisces) based on the supraethmoid bone. Trans. Illinois State Acad. Sci. 56(3):129-133.

———. 1964. A key to the Illinois species of *Ictalurus* (Class Pisces) based on pectoral spines. Trans. Illinois State Acad. Sci. 57(4):253-256.

PETERSON, J. E. 1980. Seasonal exploitation of fish resources in the Middle Missouri subarea. Unpubl. M.A. thesis (Anth.), Univ. Nebraska, Lincoln.

REHER, C. A. 1974. Population Study of the Casper site bison. Pp. 113-124, *in* The Casper Site (G. C. Frison, ed.), Acad. Press, New York and London.

SAS INSTITUTE. 1979. SAS User's Guide, 1979 Edition. SAS Institute, Cary, North Carolina.

SCHOFFMAN, R. J. 1954. Age and rate of growth of channel catfish in Reelfoot Lake, Tennessee. J. Acad. Sci. 29(1):2-8.

———. 1955. Age and rate of growth of the yellow bullhead in Reelfoot Lake, TN. J. Tennessee Acad. Sci. 30(1):4-7.

SNEED, K. E. 1951. A method for calculating the growth of channel catfish, *Ictalurus lacustris punctatus*. Trans. Amer. Fish. Soc. 80:174-183.

LITERATURE CITED (continued)

SPIESS, A. 1976. Determining season of death of archaeological fauna by analysis of teeth. Arctic 29:53-55.

———. 1978. Zooarchaeological evidence bearing on the Nain area Middle Dorset subsistence cycle. Artic Anth. 15(2): 48-60.

———. 1979. Reindeer and Caribou Hunters: An Archaeological Study. Acad. Press, New York and London.

TAYLOR, L. R. 1961. Aggregation, variance and the mean. Nature 189:732-735.

WEATHERLY, A. H. and S. C. ROGERS. 1978. Some aspects of age and growth. Pp. 52-74, *in* Ecology of Freshwater Fish Production (S. D. Gerking, ed.). Blackwell Scientific Publ., Oxford.

NOTES

1. The Middle South includes the states of Tennessee, southern Kentucky, northern Georgia, northern Alabama and northern Mississippi.
2. Raw data on all specimens used in this study are presented elsewhere (Morey 1982).
3. The Central Plains includes the states of Nebraska, the northern two-thirds of Kansas, eastern Colorado, southeastern Wyoming, extreme western Iowa and extreme northwestern Missouri.

Book Review

Medicinal Uses of Plants by Indian Tribes of Nevada. Percy Train, James R. Henrichs, and W. Andrew Archer. 139 pp. Quarterman Publications, Inc., Lawrence, MA, 1981. $25.00.

Medicinal Uses of Plants by Indian Tribes of Nevada began as a Depression-era project with three major objectives: recording the medicinal uses of native plants, collecting sufficient material for pharmacological screening, and accumulating herbarium specimens for a flora of Nevada. Percy Train collected data on the medicinal uses of 194 species of plants by the Moapa Paiutes, Paiutes, Shoshone, and Washoe along with native plant names. One hundred and nine of these plant species were screened for bactericidal properties, chemotheraputic effects, alkaloids, ascorbic acid content, effect on blood pressure, and effect on rabbit smooth muscle. Standard extracts of 83 species were also tested for toxic effects and minimum lethal dose.

A volume on medicinal plants with detailed pharmacological data is a rare find indeed and herein lies the major utility of this work. Species or genera are common to most of the surrounding states so researchers outside the borders of Nevada will appreciate this book. This volume should be added to the libraries of Poison Control Centers in the western United States.

The basic botanical data in this volume first appeared in *Contributions Toward a Flora of Nevada* No. 33, 1941. An edited version with a summary of the pharmacological research was published by W. Andrew Archer as *Contribution* No. 45 in 1957. The Quarterman edition is a facsimile reproduction of the 1957 publication. Unfortunately, $25.00 is a little expensive for a typescript copy of an earlier work.

CHM

NEWS AND COMMENTS

SEVENTH ANNUAL ETHNOBIOLOGY CONFERENCE

Having learned that the next meeting of the Society of American Archaeology is scheduled for April 11-15, 1984, in Portland, Oregon, we have set the seventh ethnobiology conference to immediately follow, April 15-17, 1984, convening at the University of Washington in Seattle. This should facilitate attendance at both meetings by those with overlapping interests in ethnobiology and archaeology. Consult forthcoming issues of *American Antiquity* for detailed information on the SAA meetings. For the ethnobiology conference, a reception is planned on Sunday evening, April 15th with paper sessions on Monday and Tuesday. A call for papers will be issued later. For further information contact Dr. Eugene Hunn, Department of Anthropology, University of Washington, Seattle, WA 98195.

ON ANTS AND ARTHRITIS

Nina M. Woessner, plant recorder for the Fairchild Tropical Garden, Miami, Florida, responded to our note in the last issue (Vol. 2, No. 2, pg. 179) concerning a jungle tree-dwelling ant the venom of which was thought to be of value in the treatment of arthritic pain and inflammation. Mrs. Woessner sent a clipping from the April 1982 *Newsletter* of the University of Miami/Jackson Memorial Medical Center describing the work of Drs. Duane R. Schultz and Roy Altman of the University of Miami's School of Medicine assessing the therapeutic value of an extract of the venom of a species of *Pseudomyrma* (cited as *Pseudomyrmex)* which inhabits the polygonaceous tree *Triplaris americana* L. Dr. Schultz became intrigued by the potential of such treatment after observing Bolivian Indians suffering the very painful bits of this ant to relieve their arthritis. The sufferer "strikes the tree with the affected part of the body. The ants swarm out, inject venom through their abdominal lancets, and the person's arthritis is often relieved." Double-blind studies at the UM Medical Center—supported by the Kroc Foundation—have confirmed that the venom extract indeed facilitates remission in rheumatoid arthritis patients. A pharmaceutical company is planning to market a derivative drug when testing is completed.

These ants are part of a fascinating community of coevolved organisms described by William Morton Wheeler in his "Studies of Neotropical Ant-Plants and their Ants" *(Bulletin of the Museum of Comparative Zoology at Harvard College,* Vol. 90, No. 1, 1942). The several species of *Triplaris* grow by preference in low, swampy places throughout the American tropics from Mexico south. Each hosts a menagerie of ants, scale insects, fungi, and round worms within the hollow internodes of their trunks (which in some species may grow to 30 meters), branches, and twigs. A structural feature of stem growth gives rise to an opening in the bud scar of each node by which the ants and other resident forms enter. The relationship of the ants and the tree is quite likely symbiotic as the ants vigorously attack any animal which has the misfortune to touch the tree. In some instances the ants kill all ground vegetation within a ring of a few meters radius, which may reduce competition for nutrients needed by the host tree. Yet, in contrast to other myrmecophilous plants, no extrafloral nectaries are provided to attract and sustain the ants. How such thriving ant populations survive on trees which may be isolated by floodwaters for months each year puzzled researchers until the complex relationships between the ants and their coresidents of the inner world of the *Triplaris* trunks was made clear. Aphid-like scale insects (coccids) share the ants' nests and feed on plant tissues excavated by the ants. These ants do not "milk" the coccids, as some ants do their aphid "cattle," but rather serve up coccid steaks to their larvae, using them as "beef [cattle] . . . rather than . . . as milch cows." The ants construct "latrines" within their nearly self-contained plant stem homes which support a lush growth of a delicate fungus. The fungus supports a highly specialized nematode worm. The ants crop the fungal hyphae, mix them with the bodies of nematodes and coccids in a sort of stew which they then feed to their larvae. Occasional forays outside by the adult ants for other insect prey is apparently sufficient for the growth and energetic needs of the ant colony. A veritable Journey to the Center of the Earth!

ETHNOZOOCRIMINOLOGY

B. Berlin forwards the following report from Ted Mann's column in *Omni* (Vol. 5, No. 6, March 1983). Canadian customs agents sought a less obtrusive means to sniff out contraband drug shipments than the trained dogs widely employed south of the border. They embarked *(sic.)* upon an ambitious experiment training gerbils to push a button activating a red light alerting the law at the first olfactory hint of narcotics. "But before the gerbils could be deployed, tragedy struck. By accident, or perhaps by criminal design, the eight-rodent team was given contaminated water" and shortly were found "paws up, on the bottom of their cage/barracks." The project continues under tightened security.

WILL COTTONSEED OIL CURE CHAUVINISM

As reported by Don Carter in the Seattle *Post-Intelligencer,* Dr. Guozhen Liu, member of the Chinese Academy of Medical Sciences and staff member of the Capital Hospital in Peking, is in Seattle to further his investigation of gossypol, a derivative of cottonseed oil, as a male contraceptive agent. Chinese researchers first noted the association of gossypol and low fertility while investigating outbreaks of an unfamiliar illness called by rural Chinese "the burning fever." It was traced to the toxic action of gossypol, a constituent of cottonseed oil which had been neutralized by traditional heat-processing techniques of extracting the oil, but which remained in cold-pressed oil. An epidemiological link to low fertility led to the discovery that very small does (50 milligrams per week) will prevent sperm production in the human male. Most subjects studied regained their fertility a few months after terminating treatment, however, the possibility of permanent loss of fertility and other serious side effects is the subject of continuing investigation. If the drug proves safe, Dr. Liu foresees it providing a way to overcome one of the greatest obstacles to birth control, that is, "male chauvinism," which Liu believes inhibits adoption of the traditional male birth control measures, vasectomy and the condom.

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed double-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses,* i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Department of General Biology
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

With this issue, the editors of the *Journal of Ethnobiology* are adding a book review section. We welcome suggestions on books to review or actual reviews from the readership of the *Journal.* Please send suggestions, comments, or reviews to Charles H. Miksicek, Office of Arid Lands Studies, University of Arizona, Tucson 85721.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to P.O. Box 1145, Flagstaff, Arizona 86002. Subscription rates are $25.00, institutional; $15.00 regular members, for U.S., Canada, and Mexico; foreign subscribers add $6.00. Write checks payable to *Journal of Ethnobiology.* Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

CONTENTS

Journal of Ethnobiology

VOLUME 3, NUMBER 2 DECEMBER 1983

JOURNAL ORGANIZATION

Journal of Ethnobiology is published semi-annually. Manuscripts for publication and information for the "News and Comments" section should be sent to the appropriate editor as explained on the inside back cover of this issue.

ISSN 0278-0771

Journal of Ethnobiology

VOLUME 3, NUMBER 2 DECEMBER 1983

SKETCHES IN THE SAND

In an early recollection from childhood I see my older brothers and sisters practicing homework using stubby pencils and wrapping paper which had been ironed smooth of wrinkles to be copied later in pads of yellow paper. I also see my parents making preliminary lists on wrapping paper then copying the final, pared-down versions on order blanks from the mail order catalogues.

I was still a towheaded preschooler when I became aware that sometimes there's a need to communicate in writing or through drawings and there's no pencil and paper handy. During an exciting summer, after the hay was in the loft and the corn laid by, my family resumed work on digging a basement for a new house. My father—"Dad" to all his children and to all the kids in the community—had stopped work on the excavation to instruct my older brothers how to shore up the collapsing walls. When both talk and gestures produced only uncertain results, Dad solved the problem with sketches scratched into the sand.

As far as I can recall, my first use of this handy technique happened after I had completed the first grade. By this time my hair had darkened and I was no longer called a towhead. My mother—"Mom" to all the youngsters around—had been hailed to the driveway by the honking of a horn. Mrs. "X", from town, had driven out to our farm for butter and eggs. These transactions were made from the car, for although Mom always invited her in for refreshments, Mrs. "X" protested that she was in a hurry. Both women knew the real reason: likely the kitchen would appear a clutter with food in various states of being processed—butter being churned, cottage cheese being drained, peas being canned, strawberries being turned into jam. On this occassion Mom called me to the driveway to fetch the merchandise and to help with the figuring. I amused both my mother and Mrs. "X" by using my bare big toe to calculate in the sand the price of three pounds of butter at 35c per pound and four dozen eggs at 27c a dozen. Knowing that Mrs. "X" often changed her mind deciding that on second thought she really could use more eggs, I hastily retreated for my mastery of multiplication tables ended at five and I didn't want to expose my limited arithmetic abilities!

By the time I was in the fifth grade my hair had darkened to a warm brown shade—the same shade as certain strands in the coat of "Pete", our pet racoon. During the week after we had finished putting all the corn fodder in the shocks, my teacher told her version of the story of Dido and Aeneas, mentioning that it was part of a larger work—an epic poem. And it was this vision of past glory that inspired my *magnum opus* in the genre of sand sketching. I determined to write an epic poem.

The following Saturday, after spending the morning gathering and hulling walnuts, I alternately scooted my behind and my knees along the footpath that led from the back door of the house past the Chinese elm tree, three black walnut trees, a Maiden Blush apple tree, and ended at the shed where we boiled down the juice from cane sorghum to make molasses. As I gradually moved along the lengthy path (about half the length of a football field) I managed to stain my faded overalls on the grass, wear out the seat of my pants and write a poem about the Huckleberry Queen, a local almost legendary rough-and-tumble character who operated a berry picking camp about whom old-timers sometimes spoke in a vague, almost forgotten manner. So in my version she became a Pottawatomie Indian Princess who fell in love with and was abandoned by her French lover/explorer and who then lived forever within the confines of the many bogs of the area. Unfortunately for this work, I was unsuccessful in convincing family members to avoid walking on the path until I could copy my masterpiece on paper. Thus my sketch may well be the longest in all history and also the shortest lived. Sketches in the sand are indeed ephemeral.

It was a revelation of high school years to learn, as I did when I first read John Steinbeck's celebrated novel "The Grapes of Wrath", that my family had no monopoly on using the earth as a slateboard. I recall being a bit miffed to learn that this craft was not invented by my family and being forced reluctantly to accede that this was yet another example of the adage that there's nothing new under the sun. Since then, of course, I have observed many rural folks engaged in this sort of activity and it has been reported in the ethnobiological literature. Gary P. Nabhan gives an excellent example (Papago Fields: Arid Lands Ethnobotany and Agricultural Ecology, unpubl. dissert., Univer. Arizona, 1983:164): "The positioning of brush weirs to control meanders, divert water into fields from nearby channels, and encourage the deposition of floodwash is a folk engineering science that Papago farmers often discuss among themselves. By drawing diagrams in the dirt with sticks, they illustrate the logic of various brush weir placements."

As a young adult changes in hormone balance (so I'm told) promoted the progressive loss of my hair and after wearing a toupee for many years, I became liberated this past summer. Sketches in the sand, like hair or at least our reaction to it, may be of temporary importance, may be an idle, self-satisfying activity, or may influence a family or society for many years or decades. What better title for an editor's column?

WV

J. Ethnobiol. 3(2):99-108 December 1983

PREHISTORIC BIRD BONE FROM THE BIG DITCH SITE, ARIZONA

ALAN FERG
*Arizona State Museum, University of Arizona
Tucson, AZ 85721*

and

AMADEO M. REA
*San Diego Natural History Museum, Balboa Park
San Diego, CA 92112*

ABSTRACT.–Fifteen individual bones and one nearly complete skeleton, representing eight bird species, were recovered from the Big Ditch Site, a large Hohokam pithouse village in the lower San Pedro River Valley, Pinal County, Arizona. Contexts date primarily from late Santa Cruz and early Sacaton Phases, around A.D. 850-950. We present osteological and provenience data for each bone and note other Hohokam occurrences for each species.

We document a Northern Cardinal premaxilla from Big Ditch (dating apparently around A.D. 550-700) and another premaxilla dating around A.D. 1150-1225 from a site 40 km upstream. The apparent absence of this species from southern Arizona prior to the late 1800s leads us to suggest that brilliantly colored cardinals, like macaws, may have been a prehistoric trade item to southern Arizona derived from somewhere farther south in Mesoamerica.

INTRODUCTION

The Big Ditch Site (AZ BB:2:2 - ASM) is a Hohokam pithouse village located on the second terrace above the east side of the San Pedro River. The locality is about 1.6 km north of the river's confluence with Aravaipa Creek in Pinal County, Arizona (Fig. 1). It was occupied from at least late Snaketown Phase times through the middle of the Sedentary Period *(circa* A.D. 500 to 1050 or 1100). This was possibly followed by a short hiatus, succeded in turn by a Tanque Verde Phase occupation *(circa* A.D. 1150-1250). Calendrical dates for periods and phases follow Haury (1976: Table 16:1). The earliest occupation at Big Ditch is represented by at least several pithouses, with the greatest extent of the village occuring during the late Santa Cruz and early Sacaton Phases, about A.D. 850-950. At present, it is estimated that as many as 25-30 pithouses may have been occupied contemporaneously at the height of occupation, with the absolute number of structures at the site being much greater (Masse 1980a:208, 216). A ballcourt was also present at the site during this maximum occupation.

As of this writing, nine pithouses and some thirty cremation deposits have been excavated, with test excavations made in six areas of sheet trash and in four of the 48 trash mounds at the site. This excavation probably represents less than 5% of the areal extent of the Big Ditch Site (Masse 1980a:208).

Located in the Lower Sonoran Life Zone (Lowe 1964) at an elevation of approximately 1658 m, the site currently supports a variety of plant species including saguaro *(Cereus giganteus)*, mesquite *(Prosopis* sp.), paloverde *(Cercidium microphyllum)*, cholla *(Opuntia* spp.) and creosote *(Larrea tridentata)*. About 1.2 km north of the site is Cooks Lake, a small marshy body of water that attracts water birds. This natural lake was probably available to water fowl prehistorically as well.

We report here one bird bone recovered during the 1974-1975 excavations directed by Dudley Meade, and all of the bird bones recovered during the 1975-1977 excavations directed by W. Bruce Masse, Arizona College of Technology Archaeological Field School (15 elements and one virtually complete skeleton; Table 1). In the following text and in Table 1, reference is made to upper, middle, lower and floor fill in pithouses. Floor fill

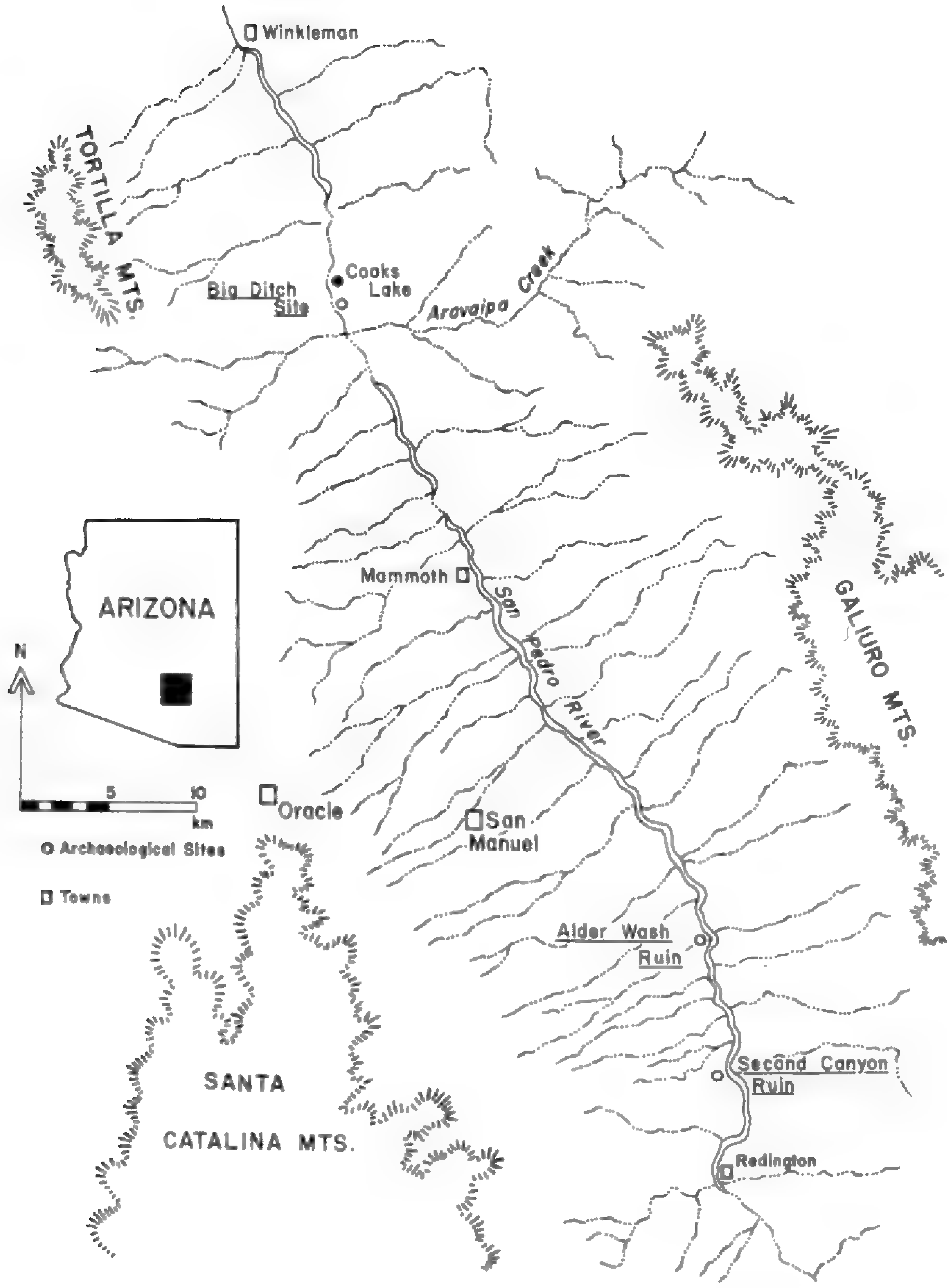


FIG. 1–Locality map for the lower San Pedro River Valley.

is defined as the 10 cm of fill immediately above the pithouse floor, and is so segregated because of its potential for containing materials that were on or near the floor when the structure was abandoned. This is distinct from the rest of the pithouse fill, which, although it contains cultural material, has usually washed in from adjacent areas or been thrown in as trash, and is consequently of little or no use in interpreting activities in the pithouse. It must be stressed that "floor fill" too can consist of materials thrown or washed into an abandoned structure, which may actually be more closely related (contextually) to items above them, rather than to anything on the floor. The two fragments of a Snow Goose humerus discussed below illustrate this well. The species descriptions below are presented in phylogenetic order following the American Ornithologists' Union *Check-List of North American Birds* (1957).

SPECIES DESCRIPTIONS

Order: Anseriformes
Family: Anatidae
Snow Goose *(Anser caerulescens)*

The distal end of a right humerus and part of the shaft of the same bone were recovered from the floor fill and lower fill, respectively, of House 3. Both pieces are burned (except for the tip of the articular end). A presumed food item, this species is distin-

TABLE 1.—*Tabulation of bird bone from the Big Ditch Site (AZ BB:2:2 - ASM).*

SPECIES	ELEMENTS	PROVENIENCE	AGE
Anser caerulescens	humerus (R)	House 3, lower and floor fill	Santa Cruz/ Sacaton
Buteo jamaicensis	1 skeleton	animal burrow (non-cultural) in Excavation Area 6	Santa Cruz or earlier
Callipepla gambelii	femur (L)	House 2, middle-upper fill	Santa Cruz/ Sacaton
	coracoid (R)	House 2, floor	Santa Cruz/ Sacaton
	coracoid (R)	House 2, floor	Santa Cruz/ Sacaton
	coracoid (L)	House 2, floor	Santa Cruz/ Sacaton
Quail, sp?	sternum	House 2, floor	Santa Cruz/ Sacaton
	radius (R)	Trash Mound 1, Level 3	Santa Cruz
	femur (R)	House 4, floor fill	Tanque Verde
Zenaida macroura	coracoid (R)	House 4, fill	Tanque Verde (?)
Geococcyx californianus	humerus (R)	House 2, middle-upper fill	Santa Cruz/ Sacaton
	tibiotarsus (L)	House 2, middle-upper fill	Santa Cruz/ Sacaton
Tyto alba	ungual phalanx	House 7, lower fill	Santa Cruz
	ulna (L)	House 1, upper fill	Sacaton or Tanque Verde
Salpinctes obsoletus	humerus (L)	House 2, floor	Santa Cruz/ Sacaton
	ulna (L)	House 2, floor	Santa Cruz/ Sacaton
Cardinalis cardinalis	premaxilla	Found in child's burial in or below Trash Mound 1	Gila Butte (?)

guishable from the similar sized *Anser albifrons* (White-fronted Goose) by the shape of the internal and external condyle and of the intercondylar furrow. This bird would have been a winter visitor, available between October and March (Phillips et al. 1964:11). *Anser "hyperborea"* and *Anser caerulescens* are the white and dark morphs, respectively, of a single species, once thought to represent two populations (A.O.U. Committee 1973). Generic usage follows Mayr and Short (1970), Phillips, et al. (1964) and Rea (1983).

The only other Hohokam site that has produced Snow Goose bones is Snaketown, Where McKusick (1976) reported (as *Chen hyperborea)* four occurrences from the Pioneer Period (300 B.C.-A.D. 550), considerably earlier than this Santa Cruz/Sacaton Phase specimen *(circa* A.D. 850-950). We have examined the Snaketown Phase (A.D. 350-550) perforated furcula listed as "Blue Goose (?)" from the 1934-1935 excavations at Snaketown (Gladwin, et al. 1937:Plate CXXIX*c* - ASM Cat. No. GP-47549), and find it is in fact a White-fronted Goose *(Anser albifrons).* This latter bone is distinguishable from the furculae of Snow Goose, Canada Goose *(Branta canadensis),* and Ross' Goose *(Anser rossii)* by the strong intermuscular lines on the interior surface which continue to the apex of its very pronounced furcular process. Also, the large pneumatic foramen in the ramus of *A. albifrons* is absent in the other three species. This is the only bird bone that has survived from the first dig at Snaketown, undoubtedly because it was worked.

Other Southwestern cultural groups also used geese furculae for pendants. Four perforated Canada Goose furculae, the two illustrated being virtually identical to the White-fronted Goose specimen from Snaketown, were found in the A.D. 1300s deposits at Pindi Pueblo near Santa Fe, New Mexico (Stubbs and Stallings 1953:138, Plate 34*h).*

Order: Falconiformes
Family: Accipitridae
Red-tailed Hawk *(Buteo jamaicensis)*

A single, almost complete skeleton of a Red-tailed Hawk was found partially articulated in an animal burrow in Excavation Area 6. All major elements were present except the left humerus, the right coracoid, the right carpometacarpus, both scapulae and the mandible. The specimen was compared with other expected buteonine species including *Buteo lineatus* (Red-shouldered Hawk), *B. albonotatus* (Zone-tailed Hawk), *B. regalis* (Ferruginous Hawk), *B. nitidus* (Gray Hawk), *Parabuteo unicinctus* (Harris' Hawk), and *Buteogallus anthracinus* (Common Black Hawk). Although this specimen is non-cultural, the burrow mouth was sealed by Santa Cruz/Sacaton Phase trash and it can be considered of Santa Cruz age (A.D. 700-900) or slightly earlier. Red-tailed Hawks are year around residents virtually statewide in Arizona.

Culturally deposited remains of Red-tailed Hawk of an approximately equal age have been found at the Cemetary Ridge Site along the middle Santa Cruz River (S. Olsen 1977:178), dating around A.D. 900. Utilization of all species of hawks and eagles is much greater during the Classic Period, at which time they often show up as single or multiple burials (Bradly 1979:10; Emslie and Hargrave 1979:123-126; Ferg, in press; Fewkes 1912:91, 93; Gerald 1975:190; McKusick 1976; Mills and Mills 1969:136; Sparling 1974:237). Additionally, from a site near Santan, McKusick identified a Swainson's Hawk and Red-tailed Hawk burial (materials and notes in the Additional Site Information File for AZ U:14:8 at the Arizona State Museum). Found in a trash mound, associated with primarily Santa Cruz and Sacaton Red-on-buff sherds, this burial may be intrusive into the mound and actually of Classic Period age.

Order: Galliformes
Family: Phasianidae
Gambel's Quail *(Callipepla gambelii)*

Four bones representing at least two individuals were collected in House 2. The proximal left femur, one left and two right coracoids all date to Santa Cruz/Sacaton times. As might be expected from this quail's wide distribution and its relative ease of hunting and trapping, bones from this ready source of meat are found in Hohokam sites of virtually all ages. Of the two quail species expected from the San Pedro drainage, the Scaled Quail *(Callipepla squamata)* is partial to grasslands and Gambel's Quail to mesquite and cactus (Phillips et al. 1964; Rea 1973; Gavin and Sowls 1975). Because of the presence here of the Gambel's Quail, it would appear that there were probably no grasslands in the immediate vicinity of the Big Ditch Site. Generic usage follows Phillips et al. (1964), Mayr and Short (1970) and Rea (1983).

Unidentifiable Quail

Three quail bones (a partial sternum, a distal right radius and a partial right femur shaft) were too fragmentary to be identified as either Scaled Quail or Gambel's Quail. The sternum from House 2 may well be from a Gambel's Quail in that the other four quail bones from this pithouse are Gambel's.

Order: Columbiformes
Family: Columbidae
Mourning Dove *(Zenaida macroura)*

The right coracoid of a Mourning Dove was found in the fill of House 4 and is probably Tanque Verde Phase in age (A.D. 1150-1250). This bird would have been a year around resident in the San Pedro Valley and is distinguished osteologically from its close relative the White-wing Dove *(Z. asiatica)* by smaller size.

Various archaeological finds of Mourning Dove have been made, including specimens of both older and younger age than the Big Ditch specimen, from Snaketown (McKusick 1976), Ventana Cave (Haury, et al. 1950:Table 11), the Davis Ranch Site (Gerald 1975:Table 3), and the Hardy Site (Gregonis, in prep.; Gregonis and Reinhard 1979). Mourning Doves, like quail, were probably utilized as a food resource.

Order: Cuculiformes
Family: Cuculidae
Greater Roadrunner *(Geococcyx californianus)*

This full-time resident of southern Arizona is represented by a distal left tibiotarsus and a distal right humerus. Both are from the middle-upper fill of House 2 and could well be from the same individual.

Archaeologically, the Roadrunner, too, is present at a number of sites, in contexts both older and younger than the Big Ditch specimens, including Snaketown (McKusick 1976), Ventana Cave (Haury et al. 1950:Table 11), the Davis Ranch Site (Gerald 1975: Table 3), Las Colinas (Rea 1981), Pisinimo (Masse 1980b:270) and the University Indian Ruin (Ferg, in press). Roadrunner feathers continue to be used in Pueblo ceremonial items, but among historic Pimans they were avoided as being a source of sickness (Bahr et al. 1974).

Order: Strigiformes
Family: Tytonidae
Barn Owl *(Tyto alba)*

One complete ungual phalanx (claw) was recovered from the lower Santa Cruz (A.D. 700-900) age fill of House 7, and the distal end of a left ulna came from the Sacaton or Tanque Verde age upper fill of House 1. Barn Owls are permanent residents in the San Pedro Valley.

The only other known archaeological occurrences of the Barn Owl in a Hohokam site are three bones from the upper (dry) midden (levels 1 through 4) in the upper cave at Ventana Cave (Haury et al. 1950:Table 11). While these bones are probably from the Hohokam occupation, because of the considerable mixing of the upper deposits (Haury et al. 1950:341-342) all that can be said with certainty is that they probably date after about A.D. 1. Upper level bones *could* relate to Papago use of the cave, or could even be post-occupational (as the White-wing Dove may be; see Rea 1983:159-160).

Order: Passeriformes
Family: Troglodytidae
Rock Wren *(Salpinctes obsoletus)*

A complete left humerus and left ulna were found on the floor of House 2. Both bones are well preserved and appear to be from the same individual. These are larger than the Cañon Wren *(Catherpes mexicanus)* and Bewick's Wren *(Troglodytes bewickii)*. This bird is probably a full-time resident in the San Pedro Valley, and prefers living in cliffs, hills, and even in areas with high dirt banks. No other archaeological specimens are known for the Hohokam area.

Family: Emberizidae
Northern Cardinal *(Cardinalis cardinalis)*

During the 1974-1975 work at Big Ditch, the premaxilla of a Northern Cardinal was found, apparently associated with what is seemingly a Gila Butte Phase (A.D. 550-700) burial in or below Trash Mound 1. The burial was that of a child, three to six years of age, with Gila Butte Red-on-buff ceramics in the lower fill of the grave (Dudley Meade, pers. comm.).

Only two other prehistoric occurrences of the Northern Cardinal in Arizona are known. The first is from another Hohokam site, Alder Wash Ruin (AZ BB:6:9 - ASM), located 40 km upstream (south) from Big Ditch, on the west bank of the San Pedro River (Fig. 1). This specimen is also a premaxilla, but dates to about A.D. 1150-1225, having been found on the floor of an early Classic Period pithouse, House 17 (Masse, in prep; Johnson n.d.*a*.).

Three Northern Cardinal elements (one mandible and one right tibiotarsus with an associated terminal phalanx) have been reported from the fourteenth century Grasshopper Pueblo (AZ P:14:1 - ASM) in the White Mountains of east-central Arizona (J. Olsen 1980:163-164; 1982:66). None show any modification.

The bill of the related Pyrrhuloxia *(Cardinalis sinuatus)* is quite differently shaped. Both Hohokam archaeological specimens are illustrated in Fig. 2, along with modern specimens of the Northern Cardinal and Pyrrhuloxia.

DISCUSSION

All eight bird species in the archaeological assemblage (including the non-cultural Red-tailed Hawk) can be found year-round in the vicinity of the site today, except for the winter visitor Snow Goose. Although the Northern Cardinal is now a common resident of southeastern Arizona north to the Mogollon Rim, such was apparently not always the case. Phillips (1968:151) notes that "This gorgeous bird, apparently rare and local in the early 1870's and conceivably absent from Arizona a few years before, had spread by 1885 north to the Agua Fria River." Its colonization of the Big Sandy-Bill Williams drainage has occurred since about 1940 (Monson and Phillips 1981). A similar recent northward range extension in south-central Arizona has been documented for the closely related Pyrrhuloxia (Rea 1983:89, 230-231). Based on the Northern Cardinal premaxilla from Alder Wash Ruin, Johnson (n.d.*a*) suggested that the recent range expansion of the Cardinal into Arizona represents a re-occupation of an area from which it had previously been extirpated by unknown factors. An alternative (and not mutually exclusive) explanation proposed herein is that these Cardinal beaks represent the remains of live birds or skins that were traded into the Hohokam area from somewhere farther south, in the "original" range, in prehistoric times. It has been well documented that other birds, such as macaws, obtained originally from far to the south in Mesoamerica, were traded into the

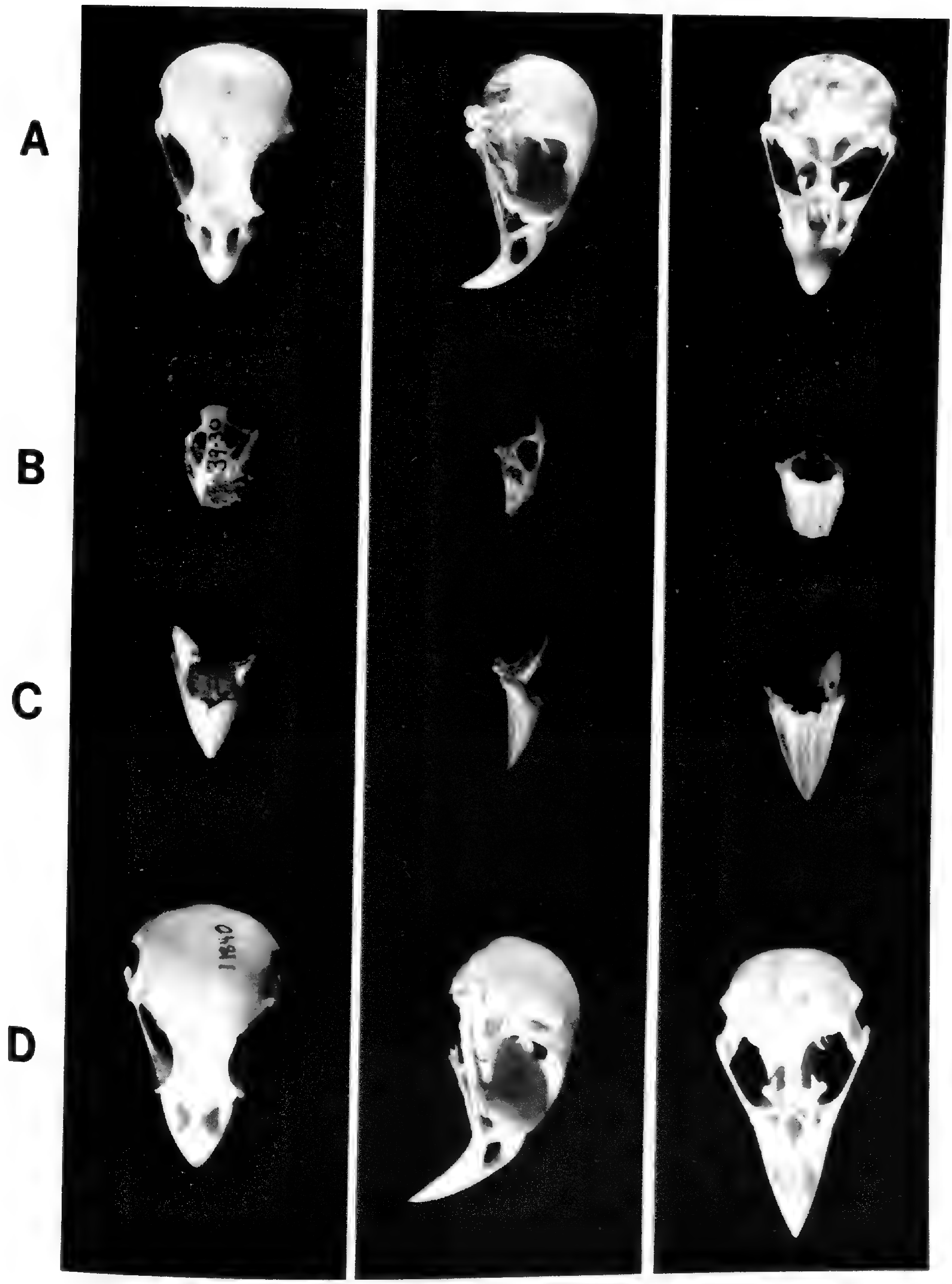


FIG. 2.–Dorsal, lateral, and palatal views of (A) modern Pyrrhuloxia skull (No. 6202 in the University of Arizona Department of Ecology and Evolutionary Biology Bird Collection), (B) prehistoric Northern Cardinal premaxilla from Alder Wash Ruin (AZ BB:6:9), (C) prehistoric Northern Cardinal premaxilla from Big Ditch Site (AZ BB:2:2), (D) modern Northern Cardinal skull (No. 11840 in the University of Arizona Department of Ecology and Evolutionary Biology Bird Collection).

Southwest (Hargrave 1970). Presumably the Cardinals traded would have been the males with their brilliant red plumage and bills.

With the present data it is not possible to say whether the Cardinal was a trade item or occurred naturally on the San Pedro in prehistoric times. The reinvasion hypothesis is unlikely. Archaeological dry cave deposits in the Hohokam area could yield identifiable Cardinal feathers, but so far have not, to the best of our knowledge. The recovery of Cardinal bones or feathers from dated prehistoric but non-cultural deposits, such as fossil packrat middens, would argue strongly for the natural presence of Cardinals in Arizona prior to the late 1800s. Again though, no such specimens are presently known.

The distribution of bird bones within the site also merits some comment. Of the sixteen bird bones reported here (the non-cultural Red-tailed Hawk being excluded), over half (nine bones or 56%) came from a single provenience, House 2 (Table 1). Of these, six bones representing at least two Gambel's Quail and one Rock Wren, were directly associated with the floor. Although the fill of House 2 represented the largest single trash deposit excavated at the site, virtually all proveniences were screened through ¼ inch mesh screens (Masse, pers. comm.), hence the high proportion of bird bones in House 2 cannot be dismissed as a problem in the manner in which the various proveniences were sampled. When the analysis of the complete floor assemblage (including all artifactual, floral and faunal materials) is completed by Masse, some further comments on this distributional situation may be possible.

A second notable relationship is that only two (12.5%) of the bones were recovered from non-pithouse proveniences even though the sampled trash mounds produced large quantities of large and small mammal bones. It is uncertain whether this restricted distribution of bird bone at the site is the result of cultural practices or of differential preservation of bird bone in different types of features.

Finally, from the 1975-1977 excavations, 2618 mammal bones were recovered, 820 of which were considered identifiable (Johnson n.d.*b*). Accordingly, bird bone (15 elements) represents 0.6% of all recovered bone, and 1.8% of all identifiable bone. At first glance, this proportion of bird to mammal bone seems quite low, but there are no large, analyzed faunal assemblages from Hohokam sites with which to compare these figures. They are noted here for comparison with any future faunal reports which may be sufficiently clearly presented that similar proportions may be calculated from them.

ACKNOWLEDGEMENTS

Dudley Meade of Central Arizona College, Coolidge, kindly loaned us the Northern Cardinal beak found at the Big Ditch Site and provided information on its provenience. W. Bruce Masse of Southern Illinois University, Carbondale, provided all data for the 1975-1977 excavations. Bruce also read and made valuable suggestions on an earlier draft of this paper. Ronald J. Beckwith, Arizona State Museum, University of Arizona, drafted the locality map, and Alison Habel of Tucson photographed the Cardinal premaxillae (the negatives are accession number 80-27 at the Arizona State Museum, Tucson).

LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION. 1957. Check-list of North American birds. 5th edition. Lord Baltimore Press, Inc., Baltimore.

AMERICAN ORNITHOLOGISTS' UNION CHECK-LIST COMMITTEE. 1973. Thirty-second supplement to the American Ornithologists' Union Check-list of North American birds. Auk 90:411-419.

BAHR, DONALD M., JUAN GREGORIO, DAVID I. LOPEZ and ALBERT ALVAREZ. 1974. Piman shamanism and Staying Sickness *(Ká:cim Mûmkidag)*. Univ. Arizona Press, Tucson.

BRADLEY, BRUCE. 1979. Arizona BB:11:2 —Redington Ruin: report on the excavation of Feature No. 1. Unpubl. Ms. deposited at Arizona State Museum Library, Univ. Arizona, Tucson.

EMSLIE, STEVEN D. and LYNDON L. HAR-

LITERATURE CITED (continued)

GRAVE. 1979. Avifauna from the Curtis Site, southeastern Arizona. Kiva 44(2-3): 121-131.

FERG, ALAN. in press. Avifauna of the University Indian Ruin, Tucson, Arizona. Kiva.

FEWKES, J.W. 1912. Casa Grande, Arizona. 28th Annu. Rep. Bur. Amer. Ethn., Washington, D.C.

GAVIN, THOMAS A. and LYLE K. SOWLS. 1975. Avian fauna of a San Pedro Valley mesquite forest. J. Arizona Acad. Sci. 10 (10):33-41.

GERALD, REX ERVIN. 1975. Drought correlated changes in two prehistoric pueblo communities in southeastern Arizona. Unpubl. Ph.D. dissert. (Anthr.), Univ. Chicago.

GLADWIN, H.S., EMIL W. HAURY, EDWIN B. SAYLES, and NORA GLADWIN. 1937. Excavations at Snaketown: material culture. Medallion Papers 25. Gila Pueblo, Globe, Arizona.

GREGONIS, LINDA M. in prep. The Hardy Site at Fort Lowell Park.

GREGONIS, LINDA M. and KARL J. REINHARD. 1979. Hohokam Indians of the Tucson Basin. Univ. Arizona Press, Tucson.

HARGRAVE, LYNDON L. 1970. Mexican macaws: comparative osteology and survey of remains from the Southwest. Anthrop. Papers Univ. Arizona 20, Tucson.

HAURY, EMIL W. 1976. The Hohokam: desert farmers & craftsmen. Univ. Arizona Press, Tucson.

HAURY, EMIL W., K. BRYAN, E.H. COLBERT, N.E. GABEL, C.L. TANNER and T.F. BUEHRER. 1950. The stratigraphy and archaeology of Ventana Cave, Arizona. Univ. Arizona Press and Univ. New Mexico Press, Tucson and Albuquerque.

JOHNSON, PAUL C. n.d.*a.* An analysis of animal remains from Alder Wash Ruin (BB:6:9) and the Dos Bisnagas Site (BB: 6:6). Appendix D, *in* The Peppersauce Wash Project: excavations at three multicomponent sites in the lower San Pedro Valley, Arizona (W. Bruce Masse). Contr. to Highway Salvage Arch. in Arizona 53 (in prep.). Arizona State Museum, Univ. Arizona, Tucson.

———. n.d.*b.* Archaeological fauna from the Big Ditch Site. Unpubl. Ms. deposited with the author.

LOWE, CHARLES H. (ed.). 1964. The vertebrates of Arizona. Univ. Arizona Press, Tucson.

McKUSICK, CHARMION RANDOLPH. 1976. Avifauna. Pp. 374-377, *in* The Hohokam: desert farmers & craftsmen (Emil W. Haury). Univ. Arizona Press, Tucson.

MASSE, W. BRUCE. 1980a. The Hohokam of the lower San Pedro Valley and the northern Papagueria: continuity and variability in two regional populations. Pp. 205-223, *in* Current issues in Hohokam prehistory, proceedings of a symposium (David Doyel and Fred Plog, eds.). Arizona State Univ. Anthrop. Res. Papers 23, Tempe.

———. 1980b. Excavations at Gu Achi: a reappraisal of Hohokam settlement and subsistence in the Arizona Papagueria. Western Archaeol. Center Publ. Anthr. 12. National Park Service, Tucson.

———. in prep. The Peppersauce Wash Project: excavations at three multicomponent sites in the lower San Pedro Valley, Arizona. Contr. to Highway Salvage Arch. in Arizona 53. Arizona State Museum, Univ. Arizona, Tucson.

MAYR, ERNST and LESTER L. SHORT. 1970. Species taxa of North American birds: a contribution to comparative systematics. Publ. Nuttall. Ornith. Club 9.

MILLS, JACK P. and VERA M. MILLS. 1969. The Kuykendall Site: a prehistoric Salado village in southeastern Arizona. El Paso Archaeol. Soc. Special Rep. 6.

MONSON, GALE and ALLAN R. PHILLIPS. 1981. Annotated checklist of the birds of Arizona, 2nd edition. Univ. Arizona Press, Tucson.

OLSEN, JOHN W. 1980. A zooarchaeological analysis of vertebrate faunal remains from the Grasshopper Pueblo, Arizona. Univ. Microfilms, Inc., Ann Arbor.

———. 1982. Prehistoric environmental reconstruction by vertebrate faunal analysis, Grasshopper Pueblo. Pp. 63-72, *in* Multidisciplinary research at Grasshopper Pueblo, Arizona (William A. Longacre, Sally J. Holbrook and Michael W. Graves, eds.). Anthrop. Papers Univ. Arizona 40, Tucson.

OLSEN, SANDI L. 1977. Faunal analysis of four sites. Pp. 178-181, *in* Excavations in the Middle Santa Cruz River Valley, southeastern Arizona (David E. Doyel). Contr. to Highway Salvage Arch. in Arizona 44. Arizona State Museum, Univ. Arizona, Tucson.

PHILLIPS, ALLAN R. 1968. The instability of the distribution of land birds in the Southwest. Pp. 129-162, *in* Collected

LITERATURE CITED (continued)

papers in honor of Lyndon Lane Hargrave (Albert H. Schroeder, ed.). Papers Archaeol. Soc. New Mexico 1. Albuquerque.

PHILLIPS, ALLAN, JOE MARSHALL and GALE MONSON. 1964. The birds of Arizona. Univ. Arizona Press, Tucson.

REA, AMADEO M. 1973. The Scaled Quail *(Callipepla squamata)* of the Southwest: systematic and historical consideration. Condor 75(3):322-329.

———. 1981. Avian remains from Las Colinas. Pp. 297-302, *in* The 1968 excavations at Mound 8, Las Colinas Ruins Group, Phoenix, Arizona (Laurens C. Hammack and Alan P. Sullivan, eds.). Arizona State Mus. Archaeol. Ser. 154. Arizona State Museum, Univ. Arizona, Tucson.

———. 1983. Once a river: bird life and habitat changes on the middle Gila. Univ. Arizona Press, Tucson.

SPARLING, JOHN B. 1974. Analysis of faunal remains from the Escalante Ruin Group. Pp. 215-253, *in* Excavations in the Escalante Ruin Group (David E. Doyel). Arizona State Mus. Archaeol. Ser. 37. Arizona State Museum, Univ. Arizona, Tucson.

STUBBS, STANLEY A. and W.S. STALLINGS, JR. 1953. The excavation of Pindi Pueblo, New Mexico. Monographs of the School of American Research and the Laboratory of Anthropology 18. Santa Fe, New Mexico.

J. Ethnobiol. 3(2):109-120 December 1983

AN ETHNOBOTANICAL ANOMALY: THE DEARTH OF BINOMIAL SPECIFICS IN A FOLK TAXONOMY OF A NEGRITO HUNTER-GATHERER SOCIETY IN THE PHILIPPINES

THOMAS N. HEADLAND
Summer Institute of Linguistics
Box 2270, Manila, Philippines

ABSTRACT.–The Agta are a Negrito hunter-gatherer group in the Philippines. After a brief description of their culture, language, natural environment, and folk plant taxonomy, a comparison is made between that taxonomy and the universal model proposed by Brent Berlin. While the Agta data substantiate the Berlin model in most aspects, there is one salient area of conflict. The model proposes that specific biological taxa in any language are composed of binomials. It is argued here that the Agta case is an anomaly, in that their specific plant taxa are monomials. Four hypotheses are proposed as possible explanations for this anomaly.

INTRODUCTION

Certain cognitive anthropologists, particularly Brent Berlin and his associates, argue that in any ethnobiological taxonomy the specific taxa (those found at the third level of a taxonomy) are almost always binomial "secondary" lexemes.[1] The suggestion is that this "binomiality principle" (Berlin 1978:20) may be a human universal. Most of the evidence published to date substantiates this hypothesis.

Data gathered by the present author and his wife in the 1970s, however, provide a startling exception to the hypothesis. An analysis of an ethnobotanical taxonomy of the Agta Negritos found that of the sample of 143 specific taxa elicited from Agta informants, only five were binomials, and none of these were secondary lexemes. Furthermore, to the author's knowledge, no secondary biological lexemes were found to occur in the Agta language, except for the two varietal taxa mentioned in Note 3.

After an introductory description of the Agta sociocultural system, including their natural environment, economy, language, and their relationship with the flora and vegetation, a brief description is presented of their folk plant taxonomy. A comparison will be made between that Agta taxonomy and the Berlin model. Emphasis will be placed on the one area where the Agta data deviate from the model. Four hypotheses will be proposed herein as possible explanations for this Agta anomaly.

THE AGTA CULTURE AND ENVIRONMENT

The culture. The Casiguran Agta, or Casiguran Dumagat, are one of approximately 25 different Negrito populations found in the Philippines today. The Casiguran Agta are a hunter-gatherer society which numbered 621 in 1977. Most of these live in one of 13 band areas in or near the Casiguran Valley in Aurora Province, on the eastern coast of Luzon Island. The Agta are seminomadic. Their temporary settlements are typically composed of from three to seven kinship-related nuclear households, located either along watersheds in the foothills of the heavily rain-forested Sierra Madre or along the beaches of the seacoast.

The environment. The geographical boundaries of the Casiguran Agta circumscribe an area of 700 km^2. Elevation ranges from sea level to a maximum of 1100 m. Average annual rainfall is 378 cm. The temperature ranges from an annual normal maximum of 31 C, to an annual normal minimum of 22 C. About half of the area is still covered by primary Dipterocarp rainforest, although most of this has been thinned of the bigger trees by loggers during the past twenty years. The Agta are today greatly outnumbered by a growing population of Filipino immigrant farmers, who now number some 30,000.[2]

Economic pursuits. Since at least the early Spanish era the economic activities of the Agta have been, for the men, hunting and fishing and, for the women, shellfishing, gathering wild yams *(Dioscorea* spp.), and extracting starch from a wild palm called **agel** *(Caryota cummingii).* Throughout the same period, a major aspect of their economics has involved the symbiotic relationship between the Agta and their lowland Filipino farming neighbors. This is manifested in heavy trading between the two populations. For at least the last hundred years, if not long before, the Agta have practiced very marginal swidden cultivation. Only about 4% of their starch foods comes from their own gardens (Rai 1982:171). Today, Agta women spend little time in the gathering of wild carbohydrate foods, since rice, secured from the non-Agta framers for which the Agta exchange meat, forest plants, or labor, is now their main staple.

Linguistic note. The Casiguran Agta speak their own distinct language, which belongs to the Northern Cordilleran subfamily of Austronesian (Tharp 1974). This language, hereinafter called Casiguran Agta, or simply Agta, is closely related to four sister languages spoken in northeastern Luzon: Palanan Agta, Agta of Southeastern Cagayan, Paranan, and Kasiguranin (Headland and Healey 1974, Headland 1975a). Casiguran Agta shares 46% of its basic vocabulary with Tagalog, and 43% with Ilokano (Headland 1975a). These are the two main trade languages of the area, and of most of Luzon Island.

In this paper, Agta terms are written phonemically. Glottal stop, which is predictable before initial vowel and after final vowels of utterances, and between certain vowel sequences, is not symbolized. The mid close central vowel (the so-called Austronesian 'pepet' vowel) is written as **é**, and the velar nasal is written as **ng**. (For a full description of Agta phonology, see Headland and Headland 1974:xii-xxvii, Headland and Healey 1974: 4-19, and Headland and Wolfenden 1967.)

Agta culture in relation to the flora. The Agta, a forest-dwelling group of hunters and gatherers, have an in-depth knowledge of the diverse flora in their environment. Merrill (1967:61) recognizes 8120 species of Philippine plants in 1524 genera. Eighty-six percent of the genera are indigenous (1308/1524), with 3% of these being endemic (35/1308). Ninety-four percent of the species are indigenous (7620/8120), with 77% of these identified as endemic (5832/7620). More recently, Zamora (1977:113) has estimated that there are 12,000 plant species in the Philippines.

The Agta are heavily oriented to the tropical rain forest, with its thousands of plant species. Agta adults can identify and name several hundred of these plants and, as Fox (1953) has demonstrated for another Negrito group, at least a few hundred of these have some cultural use. An Agta dictionary (Headland and Headland 1974) describes the names and some uses of over 200 plants among the Casiguran Agta, with half of these identified with their scientific equivalents.

The plant world is not, therefore, merely of peripheral interest to the Agta, but is a central theme in their culture, comparable to the importance of the buffalo among the Northern Plains Indians in the last century. Every Agta adult uses several species of plants every day of his life for food, medicines, ritual, art, social activities (e.g., exchange of betel ingredients), and practically every part of their material culture. Berlin (1978:9) makes the claim that, in the two nonliterate societies in which he worked, knowledge of the biological world constitutes a greater chunk than all other types of knowledge combined. I suggest here that this may be true for the Agta as well.

Earlier studies on Philippine forest groups indicate that their adult members can identify at least several hundred different plants. Rosaldo, who collected over 800 plants in the Ilongot area, estimates that the Ilongot name well over 1000 plant taxa (1972:95). Frake (1969:36) found 1400 plant taxa among the Eastern Subanun. Fox (1953) describes 600 different plants named by the Negritos in Zambales and Tarlac provinces. McKaughan and Macaraya (1965) present a list of 700 Marahao plant names. Reid and Madulid (1972) list 385 Bontoc plant names. Vanoverbergh (1927) lists 750 plant names for Ilokano, and Pennoyer (1975) lists 915 for Taubuid. Conklin collected more than

1500 plants and plant terms among the Ifugao (1967:208), and more than 1800 plant terms among the Hanunoo (1962:129). Yen and Gutierrez, collected 210 botanical specimens which are recognized by Tasaday informants, and they state that they "consider that the main species of ethnobotanical value have been accounted for" with these 210 specimens (1967:135).

AN AGTA ETHNOBOTANICAL TAXONOMY

Employing a folk taxonomic model developed by Conklin (1954) and modified by Berlin and his associates (Berlin 1976, 1977, 1978; Berlin et al. 1968, 1969, 1973, 1974: 25-45; Kay 1971), my wife and I elicited an Agta plant taxonomy, using seven Agta informants. This was done during several periods of field work in the 1970s. While Berlin's model was generally confirmed, two important theoretical issues were encountered. First, in contrast to more general models, intracultural variability in taxonomic assignment was found to be substantial among the Agta. (This issue is described in Headland 1981b.) The second issue, described in the present paper, concerns the apparent lack of secondary binomial lexemes in Agta plant taxa.

Field methodology. The procedure we used for eliciting our data combined two methods. The first, described by Werner and Fenton (1973:572), is called "card sorting." Initially, a limited sample of 108 plant taxa were taken from our Agta dictionary and written onto separate three by five cards. Informants were then asked, in separate private sessions, to sort the cards into piles they felt belonged together, for whatever reason. After each informant had categorized the 108 cards into piles, he or she would, at our suggestion, continue to subdivide each pile into smaller piles until the finest subdivision was reached. My wife and I took notes as informants explained to us their reasons for the various categories.

The second elicitation method, described by Black (1969:174), was to ask the same informants two basic questions: "What kinds of X are there?" and "Is Z one kind of Y?" With these two questions one may obtain a folk taxonomy, that is, "elicit sets of terms and . . . determine inclusion and contrast relations among all terms elicited" (Black 1969:188).

The initial sample of 108 taxa was expanded to 203 when informants were questioned with Black's method. The final sample of taxa used, then, was 203 (60 generic taxa and 143 specific taxa). These 203 taxa are listed in Headland 1981b:77-85.

Clearly this small sample of plant taxa was not a random sample of the complete Agta plant world, which would have been ideal had it been possible. Rather, the 108 taxa (later expanded to 203) were a biased sample, taken either from the Agta dictionary (Headland and Headland 1974), or from plants with which we were familiar, as well as additional specific taxa added by informants when they were questioned with Black's method. Because the argument of this paper is derived from a sample, rather than the total of Agta plant taxa, the conclusions, though persuasive, must be recognized as tentative.

We worked in some detail with the three literate informants, at least four hours with each of these, and used both elicitation methods. Sessions with the four nonliterate informants were each about two hours long. The nonliterate informants worked well with Black's method, but could only do the initial categorizing with the card sorting method. In these cases we read the cards to the informants as they placed them into piles.

The taxonomy. Our analysis revealed the emic Agta plant kingdom as composed of three primary taxonomic levels, plus three intermediate taxonomic levels, plus a unique beginner level, which we simply labeled 'plant' (since this level is not lexically realized in Agta).[3] Following the Berlin model, we named these seven levels as follows: Unique beginner, life form, intermediate level A, intermediate level B, intermediate level C, generic, and specific.

The term "unique beginner" refers to the most inclusive taxon of a taxonomy. It is the label for the taxonomy, and is the only taxon at the highest level. It does not occur in a contrast set, and it is usually not labeled linquistically (Kay 1971:87; Berlin et al. 1973:215; Conklin 1962:128).

Life form taxa in Agta correspond to the definition proposed by Berlin (1976:384; 1978). Such taxa occur at the first level of the taxonomy, are few in number, are invariably polytypic, are made up of primary lexemes, and are differentiated by stem habit. All Agta informants divided the plant world into three categories: herbs, vines, and trees.[4]

Intermediate level taxa refer to points in a taxonomy where nodes occur, but for which there is no emic plant label (though there are usually generic descriptions, such as 'herbs that bear fruit', or 'hollow trunk trees'). Such intermediate taxa are "covert categories which . . . represent groupings of generic names which are included in mid-level taxa that have not been labeled by . . . plant lexemes" (Berlin et al. 1973:226).[5] Our Agta informants classified a number of plants into covert intermediate categories. Three levels of such categories occured between the life form and generic taxa. (The details of these are not pertinent to the argument of the present paper, and are thus not described herein. Refer to Headland 1981b for a complete description of the Agta taxonomy.)

Generic taxa in Agta refer to plants which are readily perceived as different by any lay person (which is not the case with specific taxa). Agta generic lexemes are all monomials, and are included in one of the three life form taxa (with a few ambiguously affiliated exceptions). Agta generic taxa also correspond closely with the species in modern biology. Psychologically, generic taxa are the most salient in the taxonomy; they were the first terms our informants gave us in our early ethnobotanical inquiry, and they are the first terms acquired by Agta children as they learn to name plants (Berlin 1978:17; see also Stross 1974).

Specific taxa are those which are immediately included in generic taxa. Whereas generic taxa represent perceptually distinct discontinuities in the biological world, specific taxa are cognitively recognized primarily because of their cultural importance (Berlin 1978:18). As Berlin states it, generic taxa are recognized "because they are there;" specific taxa are recognized "because it is culturally important to do so" (1978:19). Most specific taxa occur in sets of two or three members, although we have found Agta specific sets of up to twenty and thirty members immediately included in some generics of major importance (e.g., the generic **uway** 'rattan' includes 22 specific types of rattan, and the generic **pahay** 'rice' includes 31 specifics).

In most ethnobiological taxonomies, it has been found that most specific taxa are binomial "secondary" lexemes. Conklin reported this to be the case for another Philippine group (1954:117), and Berlin and his colleagues hypothesize that this is a cultural universal (Berlin et al. 1973:218ff). Our data, on the other hand indicate that most Agta specfics are monomial lexemes, with only 4% of the specifics in our data being binomials. Furthermore, there are no secondary lexemes in our data, except for the two varietal taxa in Note 3. Since this phenomenon is so contrary to expectations, we discuss it in detail in the next section which is the heart of the issue and the thesis of this paper.

THE DEARTH OF BINOMIAL SPECIFICS IN AGTA

It is a basic hypothesis of Berlin that in any ethnobiological taxonomy the specific taxa found at the specific level number three will be mostly binomial "secondary" lexemes[6] (Berlin et al. 1973:218, 221, 222, 224, 240; 1974:27; Berlin 1976:390, 1977, and 1978:20). Most of the published evidence to date seems to substantiate this hypothesis, including data from the Philippines (Pennoyer 1975:209 and Conklin 1954:117, 128).[7]

This appears not to be the case, however, in Agta. We found 25 generic taxa in our sample of 60 generic plant names that were polytypic. From these 25, we found a total number of 143 specific plant taxa at level three.[8] Of these 143 specific taxa, only five are binomials. Furthermore, none of these are secondary lexemes, and there are no secondary biological lexemes, to our knowledge, in the Agta language, except for the two varietal taxa discussed in Note 3.

Of the 143 specific taxa, 65% are "simple primary lexemes," 31% are "unproductive complex primary lexemes," and 4% are "productive complex primary lexemes." (For definitions, see Note 1.) Only 4% of the Agta specific taxa in our sample are binomials (5/143).

Berlin et al. state that almost all Tzeltal specific plant names are "composed of an attributive plus a generic name" (1974:41). In contrast, we found only five such binomials among the 143 Agta specific taxa in our sample, with four of these occuring with the same attributive term, **tunay** 'genuine'. These are **tunay a palago** 'genuine Dillenia', **tunay a niyog** 'genuine coconut', **tunay a butag** 'genuine areca', and **tunay a maes** 'genuine corn'.

To illustrate with just one example the difference between Tzeltal and Agta specific lexemes, let us compare the form of the specific terms included in the generic taxon for 'banana' in both languages. In Tzeltal there are at least twelve specific classes of bananas, all of which are binomial secondary lexemes (e.g., 'white banana', 'genuine banana', 'wax banana', etc.) (Berlin 1977:84). Agta, on the other hand, has eighteen specific classes of bananas, all of which are marked by primary monomial lexemes. Ten of these are simple lexemes, and eight are unproductive lexemes.

FOUR HYPOTHESES FOR EXPLAINING THE ANOMALY

At this point the question is raised, why is the Agta case an anomaly in having so few specific terms which are binomials?[9] While more research is necessary before I will be prepared to give a definitive answer to this question, four possible hypotheses may be considered. These are presented here:

Hypothesis 1: Agta speakers tend not to use a lot of adjectives. Elsewhere (Headland 1981a) I have argued that although it is grammatically allowable, it is semantically cumbersome in Agta to use more than one adjective or adverb in a phrase. Some languages actually favor the heavy use of noun modifiers as a rhetorical device for enhancing a speech style. Koine Greek is a classic example of such a language. Banker (1980) also reports that some of the Viet Nam languages string out their sentences with extra modifying words to improve discourse style.

Agta, however, as well as several other Philippine languages, tends to be at the other end of the spectrum in its discourse style. Agta speakers are predisposed not to use a lot of modifiers in their speech. It is rare, in Agta text materials, to find two adjectives in the same phrase. When too many adjectives are inserted into Agta speech, I have argued, there is a resulting "information overload" (Headland 1981a) which causes communication blockage. This may be at least part of the reason for the dearth of binomial taxa in Agta plant names.

Hypothesis 2: Agta specific taxa are monomials because the Agta are such skilled specialists on plants that they have long ago coined primary lexemes (rather than secondary lexemes) for even those plants at the specific level. This hypothesis concords with Zipf's law (1949), which maintains that length of word varies inversely with its frequency of usage. That is, words that are used frequently will be shorter than words that are used less frequently.

Cecil Brown (drawing from Berlin 1977:96), has developed a theoretical model to explain the growth (and decline) of certain types of biological terminologies in human societies (Brown 1977:332, 1979:381, and Witkowski et al. 1981). Though Brown does not discuss any reasons as to why a language may have mostly binomial (or monomial) specifics, his model does suggest why some languages may have many specific biological taxa, while others have very few. To summarize this part of Brown's model, more complex societies tend to have more life form taxa, and fewer specific taxa, while simple societies (like the Agta) would have the opposite tendencies (but cf. Waddy 1982:70).

The reason, then, that more complex societies (with more cultural-technological development) have less specific taxa is they are not as intricately involved and dependent upon the plant world. Berlin (1977:97), for example, points out that English speakers reared in an urban environment have virtually no specific names for kinds of plants. Brown's model thus suggests that specific plant taxa are more highly salient in simple forest societies.

Carrying Brown's direction one step further, I would hypothesize that very simple societies, such as the Agta, which consist of forest dwellers who are intimately involved with and dependent upon their botanical environment, will not only have more specific plant taxa in their vocabulary, but that a majority of those taxa will be primary monomial lexemes. In the case of the Agta, therefore, I see them as skilled botanists, real folk scientists in their own right. One manifestation of this is that they have monomial plant lexemes for most of the named plants in their environment. This includes their plant taxa at the specific level.

It would be interesting to do a semantic study of automobile parts nomenclature as it is used by professional mechanics in an auto repair shop, in contrast to how the same parts might be used by the lay people in the same neighborhood. I would conjecture that the lay people would use proportionately more secondary binomials for the same parts for which the mechanics use primary monomials. James Spradley (1970) has shown the complexity of terminology of certain restricted semantic domains in English, which are known only by those who are specialists or practitioners of those customs to which the domains pertain. Spradley does not discuss the ratio of monomials to binomials in his examples, but his examples do illustrate the extreme argot which can be found in the vocabulary of those who find the items referred to in that domain as important to themselves.

The Agta definitely find the items of the plant world as very important to their lives—so important, I am suggesting, that they have simple monomial lexemes for even many of their specific plant taxa. This fits with Berlin's recent modification of his earlier models that in some languages specific taxa of major cultural importance may be monomial (Berlin 1976:392, 1978:20-21).

Hypothesis 3: Here the question is raised as to whether we are dealing here with a phenomenon similar to what Hays asserts for the Ndumba: "Binomialization is culturally permissible for nearly all Ndumba plant names but is uncommon except when used for emphasis" (1976:506, n.7). I would argue that this concept is not true for Agta plant taxa. While any plant taxon may carry a modifier within the phrase within which it is said, such modifying is rare and, in any case, I would not consider the modifier as part of the actual lexeme. Similarly, I do not believe that Agta plant lexemes correspond to what Pennoyer describes for another Philippine group: "In the Taubuid classificatory system most plant names may be potentially modified by the addition of a second attributive word and then applied to a different (but somewhat similar) plant" (1975:209).

Hypothesis 4: This hypothesis concords with a characteristic feature of the syntax of Philippine languages in general. It is common in the syntax of Agta, as well as other Philippine languages, to nominalize adjectives simply by using them in the nominal position in a sentence. That is, adjectives may be used as nouns. For example, an Agta speaker may refer to the smaller of two bolos being offered for sale in a market by saying to the vendor,

'Alapen ko tu ketihek a sondang.'

take I the small bolo

'I'll take the small bolo.'

Although this sentence is perfectly grammatical, and would sound natural, the Agta speaker would be more apt to omit the last word, 'bolo', and merely say, "**Alapen ko tu ketihek,**" 'I'll take the small (one).' This tendency in Philippine languages, for the speaker to use an adjective as a noun, is especially common when the hearer knows from the context what the speaker is referring to.

Hypothesis Four, then, suggests that originally the monomial specific plant taxa in Agta were binomials consisting of an adjective plus a noun. However, because of the ability of adjectives to serve as nouns in the language, the original generic nouns in the binomial taxa eventually came to be dropped, and the remaining adjectives became nominalized as the formal names for specific plant taxa.

Thus, for example, the specific taxon **binaybay** 'variety of rice', may have originally been called ***binaybay a pahay** (which means literally 'sandy rice'). But later the generic noun, **pahay** 'rice', was dropped, and the adjective **binaybay** became a nominalized plant taxon for referring to this particular specific variety of rice.

There is one minor problem with this hypothesis. It implies that the Agta monomial specific taxa are nominalized forms of known adjectives used elsewhere in the language. But this is the case with only 24 of the 138 specific monomial taxa in our sample. Other specific taxa may be recognized as having been borrowed from another language (usually Tagalog, probably at the same time these cultigens were first introduced into Casiguran). And some of those taxa have adjectival meanings in the languages from which they were borrowed, but not in Agta (as e.g., the variety of cassava called **merakel**, which probably comes from the English word 'miracle'). Other specific plant taxa have no meaning, to our knowledge, in either Agta or any of the major Philippine languages in Luzon, other than as present-day terms for Agta plant names. Hypothesis Four, then, suggests that these latter terms were meaningful adjectives in Agta in the past, but those original meanings are now extinct, and the forms remain today in the language only as terms for plant taxa.

Admittedly, a strong case cannot be made for the apparent near-absence of binomial specifics in Agta without first making collections of the total flora in the Casiguran area, and then eliciting from informants all or most of their plant names, which could number over a thousand. The sample of plant taxa used in the present study is small, and tends to include plants which are of cultural importance to the Agta. Berlin has more recently hypothesized that taxa of "major cultural importance" may have monomial forms at the specific level (1976:392, 1978:20-21). He has, however, also suggested to me (in personal correspondence in 1978) that if I were to elicit more taxa of plants of no cultural utility, that I would find most of the specific level labels of these taxa to be binomials.

While this may be possible, it must remain an open question for the present.[10] My knowledge and experience regarding the Agta language lead me to believe that specific binomials will be just as rare in a complete plant inventory as they are in the present sample. It is rare for Agta speakers to modify nouns with more than one adjective in a single phrase. Though grammatically allowable, it is semantically cumbersome to do so. I would be even more surprised to find any Agta plant lexemes consisting of three, four or five words, as Conklin found for the Hanunoo (1954:128).

CONCLUSION

This paper has sketched how the Agta Negritos of the Philippines break down their ethnobotanical taxonomy into three main levels—life form, generic, and specific, as well as several covert intermediate levels numbering up to three in some branches of the taxonomy.

The theoretical issue of the paper is concerned with the observation that very few of the plant taxa in the Agta data are composed of binomial lexemes. Agta plant names at the specific level (or at any level, for that matter) are mostly monomials. Only 4% of the specific taxa in the sample were binomials, and there were no secondary lexemes found in the data. The issue concerns the conflict between the data and a basic hypothesis of certain cognitive anthropologists that specific taxa in any folk taxonomy are made up of mostly binomial secondary lexemes.

Four hypotheses were presented here as possible explanations as to why the Agta case is an anomaly in having so few specific binomial terms. Hypothesis One suggested that Agta has few plant binomials because the language as a whole tends to use adjectives sparsely. Hypothesis Two suggested that the reason for the lack of binomials is because the Agta are such skilled specialists on plants that they have primary monimial lexemes for plants even at the specific level. Hypothesis Three suggested that the Agta specific taxa *are* binomials, but that the second attributive words are only used uncommonly for emphasis. In other words, the binomials are there but the investigators failed to notice them. This author rejects the possibility of Hypothesis Three being correct. Hypothesis Four suggested that originally the monomial specific taxa in Agta were binomials consisting of an adjective plus a noun. But because of the tendency in Agta for adjectives to serve as nouns, the original generic nouns in the binomial taxa came to be dropped, and the remaining adjectives became nominalized as the formal names for specific plant taxa.

There is a theoretical significance to the Agta data, as it has been described here. This involves the discovery of a language group which does not appear to use binomial lexemes for specific plant taxa. The major theoretician in the area of folk biological taxonomies, Brent Berlin, has developed a widely accepted model which proposes that the use of binomial specific taxa is a cultural universal. The present sample of Agta data, however, contradicts that model. The point is, if the Agta lexicon fails to have binomial lexemes for their specific taxa, it seems probable that other languages elsewhere do as well. It would be interesting if future research shows that this phenomenon is limited to languages spoken by so-called hunter-gatherer band-level societies, or is restricted to certain Philippine languages.

ACKNOWLEDGEMENTS

The impetus for the present study came originally from a semantics workshop conducted under the auspices of the Philippine Branch of the Summer Institute of Linguistics, in 1974. I am indebted to Kemp Pallesen for his critical comments on my taxonomic analysis during the workshop. A number of individuals have made helpful comments on earlier drafts of the present paper, and I am grateful to them. These include Brent Berlin, Jack Bilmes, Cecil Brown, Michael Forman, Bion Griffin, Richard Lieban, Kemp Pallesen, Navin Rai, Lawrence Reid, Richard Roe, Michael Walrod, Douglas Yen, and the anonymous reviewers for this journal. My wife, Janet Headland, assisted me in all aspects of the data gathering and analysis. The conclusions of this paper, however, remain my own responsibility.

Appreciation is due to Hermes Gutierrez, of the National Museum of the Philippines, for identifying certain plant specimens collected by my wife and I, and to Santiago Peña and Ruben Valencia, of the Pagasa Weather Bureau Station in Casiguran, for patiently supplying me with monthly rainfall measurements from 1962 to 1978.

The author conducted extensive field work among the Agta for most of the years from 1962 to 1979, under the auspices of the Summer Institute of Linguistics and the Philippine Ministry of Education and Culture. The data described in this paper were gathered in the field in November 1974, August 1975, July 1977, and February 1978. I am indebted to the following Agta informants from whom we elicited the data: Didog Aduanan, Eleden Aduanan, Lito Aduanan, Alonso Kukuan, Pedong Maksimino, Erminya Pawisan, and Pompoèk Sagunéd. The author is a fluent speaker of the Agta language, and all interviewing was done in that language.

LITERATURE CITED

BANKER, JOHN. 1980. How Can We Improve Our Translation Stylistically? Notes on Translation 78:31-36. (International Linguistic Center, Dallas.)

BERLIN, BRENT. 1976. The Concept of Rank in Ethnobiological Classification: Some Evidence from Aguaruna Folk Botany. Amer. Ethnol. 3:381-399.

LITERATURE CITED (continued)

———. 1977. Speculations on the Growth of Ethnobotanical Nomenclature. Pp. 63-101 *in* Sociocultural Dimensions of Language Change. *Also in* Lang. and Soc. (1972) 1:51-86.

———. 1978. Ethnobiological Classification. Pp. 9-26 *in* Cognition and Categorization (Eleanor Rosch and Barbara Lloyd, eds.) Lawrence Erlbaum Associates, Hillsdale, N.J.

BERLIN, BRENT, DENNIS E. BREEDLOVE, and PETER H. RAVEN. 1968. Covert Categories and Folk Taxonomies. Amer. Anthr. 70:290-299.

———. 1969. Folk Taxonomies and Biological Classification. Pp. 60-66 *in* Cognitive Anthropology (Stephen A. Tyler, ed.) Holt, Rinehart and Winston, New York.

———. 1973. General Principles of Classification and Nomenclature in Folk Biology. Amer. Anthrop. 75:214-242.

———. 1974. Principles of Tzeltal Plant Classification. Acad. Press, New York.

BLACK, MARY B. 1969. Eliciting Folk Taxonomy in Ojibwa. Pp. 165-189 *in* Cognitive Anthropology (Stephen A. Tyler, ed.), Holt, Rinehart and Winston, New York.

BROSIUS, PETER. 1981. After Duwagan: Deforestation, Succession, and Adaptation in Upland Luzon, Philippines. Unpubl. M.A. thesis (Anthr.), Univ. Hawaii.

BROWN, CECIL H. 1977. Folk Botanical Life-Forms: Their Universality and Growth. Amer. Anthrop. 79:317-342.

———. 1979. Growth and Development of Folk Botanical Life Forms in the Mayan Language Family. Amer. Ethnol. 6:366-385.

CONKLIN, HAROLD C. 1954. The Relation of Hanunoo Culture to the Plant World. Unpubl. Ph.D. dissert. (Anthr.), Yale Univ.

———. 1957. Hanunoo Agriculture: A Report on an Integral System of Shifting Cultivation in the Philippines. FAO, United Nations, Rome.

———. 1962. Lexicographical Treatment of Folk Taxonomies. Pp. 119-141 *in* Problems in Lexicography (Fred Householder and Sol Saporta, eds.), IJAL vol. 28, no. 2, part IV, Indiana University Research Center in Anthropology, Folklore and Linguistics, Bloomington. *Also in* Cognitive Anthropology (1969), Pp. 41-59, (Stephen A. Tyler, ed.) Holt, Rinehart, and Winston, New York.

———. 1967. Ifugao Ethnobotany 1905-1965: The 1911 Beyer-Merrill Report in Perspective. Pp. 204-262 *in* Studies in Philippine Anthropology (Mario Zamora, ed.) Alemar Publishers, Quezon City. *Also in* Econ. Botany 21:243-272.

FOX, ROBERT B. 1953. The Pinatubo Negritos: Their Useful Plants and Material Culture. Bureau of Printing, Manila.

FRAKE, CHARLES O. 1969. The Ethnographic Study of Cognitive Systems. Pp. 28-41 *in* Cognitive Anthropology (Stephen A. Tyler, ed.) Holt, Rinehart and Winston, New York.

HAYS, TERENCE E. 1976. An Empirical Method for the Identification of Covert Categories in Ethnobiology. Amer. Ethnol. 3:489-507.

HEADLAND, THOMAS N. 1975a. Report of Eastern Luzon Language Survey. Philippine J. Ling. 6:47-54.

———. 1975b. The Casiguran Dumagats Todays and in 1936. Philippine Q. Cul. and Soc. 3:245-257.

———. 1981a. Information Rate, Information Overload, and Communication Problems in the Casiguran Dumagat New Testament. Notes on Translation 83:18-27. (International Linguistics Center, Dallas.)

———. 1981b. Taxonomic Disagreement in a Culturally Salient Domain: Botany Versus Utility in a Philippine Negrito Taxonomic System. M.A. thesis (Anthr.), Univ. Hawaii. Published by Univ. Microfilms Int., Ann Arbor. Order no. 1318270.

HEADLAND, THOMAS N. and JANET D. HEADLAND. 1974. A Dumagat (Casiguran) – English Dictionary. Dept. of Linguistics, Research School of Pacific Studies, The Australian National Univ., Canberra.

HEADLAND, THOMAS N. and ALAN HEALEY. 1974. Grammatical Sketch of Casiguran Dumagat. Pac. Ling. A-43:1-54.

HEADLAND, THOMAS N., and ELMER P. WOLFENDEN. 1967. The Vowels of Casiguran Dumagat. Pp. 592-596 *in* Studies in Philippine Anthropology (Mario D. Zamora, ed.) Alemar-Phoenix, Quezon City.

KAY, PAUL. 1971. Taxonomy and Semantic Contrast. Language 47:866-887.

MATHIOT, MADELEINE. 1964. Noun Clases and Folk Taxonomy in Papago. Pp. 154-163 *in* Language in Culture and Society (Dell Hymes, ed.) Harper and Row, New York.

McKAUGHAN, HOWARD P., and BATUA A.

LITERATURE CITED (continued)

MACARAYA. 1965. Maranao Plant Names. Oceanic Ling. 4:48-112.

MERRILL, ELMER D. 1967. An Enumeration of Philippine Flowering Plants, Vol. 4 (reprint). A. Ascher and Co., Amsterdam.

PENNOYER, F. DOUGLAS. 1975. Taubuid Plants and Ritual Complexes. Unpubl. Ph.D. dissert. (Anthr.), Washington State Univ.

RAI, NAVIN K. 1982. From Forest to Field: A Study of Philippine Negrito Foragers in Transition. Unpubl. Ph.D. dissert. (Anthr.) Univ. Hawaii.

REID, LAWRENCE A., and DOMINGO MADULID. 1972. Some Comments on Bontoc Ethnobotany. Philippine J. Ling. 3:1-24.

ROSALDO, MICHELLE Z. 1972. Metaphors and Folk Classification. Southwestern J. Anthr. 28:83-99.

SPRADLEY, JAMES P. 1970. You Owe Yourself a Drunk. Little, Brown and Co., Boston.

STROSS, B. 1974. How Tzeltal Children Learn Botanical Terminology. *In* Meaning in Mayan Languages. (M.S. Edmonson, ed.) Mouton, The Hague.

THARP, JAMES A. 1974. The Northern Cordilleran Subgroup of Philippine Languages. Working Papers in Ling. 6(6):53-114, Univ. Hawaii, Honolulu.

VANOVERBERGH, MORICE. 1927. Plant Names in Iloko. J. Amer. Oriental Soc. 47:133-173.

WALLACE, BEN J. 1970. Hill and Valley Farmers: Socio-Economic Change Among a Philippine People. Schenkman, Cambridge.

WADDY, JULIE. 1982. Biological Classification from a Groote Eyelandt Aborigine's Point of View. J. Ethnobiol. 2:63-77.

WALTON, CHARLES. 1979. A Philippine Language Tree. Anthrop. Ling. 21(2): 70-98.

WERNER, OSWALD, and JOANN FENTON. 1973. Method and Theory in Ethnoscience or Ethnoepistemology. Pp. 537-578 *in* A Handbook of Method in Cultural Anthropology (Raoul Naroll and Ronald Cohen, eds.) Columbia Univ. Press, New York.

WITKOWSKI, STANLEY R., C. BROWN, and P. CHASE. 1981. Where Do Tree Terms Come From? Man 16:1-14.

YEN, D.E., and HERMES G. GUTIERREZ. 1976. The Ethnobotany of the Tasaday: I. The Use Plants. Pp. 97-136. In Further Studies on the Tasaday (D. Yen and John Nance, eds.) Panamin Found. Ser. Number 2. Panamin Foundation, Makati, Rizal.

ZAMORA, PRESCILLANO M. 1977. A Primer on Philippine Plants. Filipino Heritage 1:113-119.

ZIPF, G.K. 1949. Human Behavior and the Principle of Least Effort. Addison-Wesley, Cambridge.

NOTES

1. Berlin defines two main types of lexemes, *primary* and *secondary* (1976:397, 1978; Berlin et al. 1973:217-219, 1974:28). Primary lexemes may be of two types, *simple* primary, or *complex* primary. Complex primary lexemes may in turn be further subdivided as either *unproductive* or *productive*. Since Agta plant taxa consist of each of the three types of primary lexemes, Berlin's definitions are outlined here, with examples from the Agta data, as well as from English.

Simple primary lexemes are unique, "single word" expressions which are "linguistically unanalyzable." They are monomorphemic (i.e., unsegmentable). Conklin calls these "unitary simple lexemes" (1962:122). Examples of such lexemes in English folk biology are **oak**, **pine**, **quail**, and **bass**. Examples in Agta are **biget** 'banana', **buloktot** 'jade vine', **ogsa** 'deer', and **nabneh** 'var. of rattan'. In our sample of 203 plant taxa, 97% of the generics (58/60) and 65% of the specifics (93/143) are labeled with simple primary lexemes.

Unproductive complex primary lexemes are polymorphemic (i.e., segmentable) and are linguistically analyzable, but no constituent of the term labels a taxon superordinate to the class in question. Conklin calls these "unitary complex lexemes." Thus, **poison oak** is not a type of oak. Examples in English are **jack-in-the-pulpit**, **pineapple**, and **cat-tail**. There are 45 specific unproductive lexemes in our Agta sample. Most of these, 32, are single words with frozen derivational affixes (e.g., **tumadem** 'var. of rattan', **malagkit** 'var. of rice'). Five more are reduplicated forms of simple lexemes (e.g., **aso-aso** 'var. of rattan', **ipit-ipit** 'var. of banana'). The eight forms are compound nouns (**ipos-na-buhog** 'var. of rattan', **songsong-gabi** 'var. of taro'). Thirty-one percent of the Agta specifics in our sample are unproductive lexemes (45/143). There is one generic which may be classed as an unproductive lexeme: **makahiya** '*Mimosa pudica*', a term borrowed from Tagalog.

NOTES (continued)

Productive complex primary lexemes are also polymorphic and linguistically analyzable; however, in contrast to the unproductive lexemes, one of the constituents always labels a superordinate taxon, such as **tree** in **tulip tree**. However, such lexemes contrast directly with other taxa in the set which are simple primary lexemes or complex primary lexemes (which may be productive or unproductive). Examples in English are **crabgrass, swordfish**, and **pipevine**. There are only five examples of productive lexemes in our sample, all of which are binomial specifics; and all of the binomial specifics in our sample of Agta are productive lexemes. (These five samples are listed in Headland 1981b:90.)

Secondary lexemes are also polymorphemic and linguistically analyzable. They are, like productive primary forms, identifiable in that one of the constituents of such expressions is the same as the category superordinate to the form in question. In this case, however, in contrast to productive lexemes, secondary lexemes occur in contrast sets all of whose members are labeled by other secondary lexemes which share the same superordinate constituent. An example of such a contrast set in English is the set filled by the terms **jack oak, post oak, scrub oak, blue oak**, etc.

To our knowledge there are no secondary lexemes in Agta botanical taxa, except for the two varietal taxa in Note 3. This phenomenon does not fit the Berlin model, which states that "specific and varietal classes are labeled, with predictable exceptions, by binomial secondary lexemes" (Berlin 1976:390).

It should be noted that Conklin does not differentiate between productive complex primary lexemes and secondary lexemes in his model, but refers to both types as "composite lexemes" (1962: 122).

2. The traumatic culture change of the Agta since WWII has been described elsewhere (Headland and Headland 1974:xlviii; Headland 1975b; 1981b:2-13).

3. Berlin et al. describe a fourth level universal ethnobiological taxonomic category, called varietal, which is a further division of specific taxa. They state that this level is "rare in most folk biological taxonomies" (1973:215, 216). We discovered only one set of taxa at this varietal level, two subvarieties of the species of taro called **sampernando**. These are **melatak a sampernando** 'white sampernando taro', and **mengitet a sampernando**, 'dark sampernando taro'.

4. We hypothesize here that this three-part division of plants is universal for all Philippine groups. It has been documented for the following Philippine groups: Subanun, Hanunoo, Taubuid, and Gaddang (Conklin 1957:44; Frake 1969:36-37; Wallace 1970:10; Pennoyer 1975:210), and several colleagues of the Summer Institute of Linguistics have verified to us that this same 'herb-vine-tree' trichotomy exists in other groups in the Philippines. This contrasts with a two-part division at the life form level for the Aborigines on Groote Eylandt, Australia (Waddy 1982:70), a four-part division for the Tzeltal and the Aguaruna (Berlin et al. 1973:219; Berlin 1976:385), and a five-part division for the Papago (Mathiot 1964:156, 158) and the Ndumba of New Guinea (Hays 1976: 506, n.4). For a possible exception to this hypothesized universal, see Reid and Madulid (1972:2), and Headland (1981b:96, n.17).

5. Not every researcher handles the covert nodes in folk taxonomical studies. Conklin, for example, found intermediate levels in a Hanunoo plant taxonomy, but did not include them as levels in the taxonomy, because these midgrouping of plants were not made "according to a structured terminologically-identifiable system" (1954:97). Berlin et al., however, argue that these unlabeled covert categories are of crucial taxonomic significance, and that "the understanding . . . of a . . . domain is actually obscured if one focuses solely on lexically labeled units" (1968:290).

6. For a definition of "secondary lexemes," see Note 1. A *binomial* is defined in this paper as a native biological name consisting of two terms, one of which is the same as the superordinate taxon to the name in question, and the other of which is an attributive. This is synonymous with what Conklin calls "*composite lexemes* . . . one or more segments of which . . . designate categories superordinate to those designated by the forms in question" (1962:122). In Berlin's model, all *secondary lexemes* and *productive primary lexemes* are binomials. There were only five binomials discovered in Agta.

7. For the Hanunoo, Conklin states, "Of the total inventory of 1625 Hanunoo plant type names, 1054, or nearly two-thirds, consist of an initial basic name followed by one or more attributive

NOTES (continued)

units (961 types have only one such attribute, 87 have two, eight have three, and only two have four)" (1954:128). For the Taubuid, Pennoyer states, "Most plant names may be potentially modified by the addition of a second attributive word and then applied to a different (but somewhat similar) plant" (1975:209).

8. There are, of course, more than 143 specific plant taxa in Agta. These 143 extend only from our original sample of 108 plant lexemes. (This sample was later expanded to 203 lexemes when informants, being questioned with Black's elicitation method, added lexemes to the original sample.)

9. The Zambales Negritos of western Luzon also appear to have very few binomial plant taxa. Peter Brosius elicited approximately 300 plant terms in 1980, during his study of the responses of this population to deforestation (Brosius 1981). His sample includes specific terms for 34 varieties of banana, 16 of sweet potato, 16 of rattan, 15 of rice, 9 of taro, 8 of yam, 8 of corn, and 4 of wild banana. Of these 110 specific terms, only 5 are binomials (Brosius, personal communication).

This Negrito group lives to the immediate southwest of the population studied by Fox (1953). It should be noted that the Zambales Negritos are geographically isolated from the Casiguran Agta. They have no social interaction, and their languages, though both Austronesian, are not closely related. The shared vocabulary between Casiguran Agta and Botolan Sambal, which is spoken both by the lowland Filipinos and the Negritos in the municipality of Botolan, is 46% (Walton 1979).

10. A final answer to this question may be soon forthcoming. Melinda S. Allen, an ethnobotanist from the University of Hawaii, conducted a seven month field study of Agta ethnobotany in Cagayan Province in 1981. Allen is a co-investigator of an NSF project titled "Women Hunters in a Tropical Foraging Society," Grant No. BNS-8014308. The investigators studied an Agta group 200 km north of Casiguran, who speak a language which is 70% cognate with Casiguran Agta (Headland 1975a:50).

Allen's work was aimed at a botanical collection of all plants in fruit or flower, with an emphasis on those of economic importance. Regarding the frequency of binomials in this area, she wrote me on June 29, 1981 saying, "To date 293 folknames have been elicited for an unspecified number of Latin equivalents. Of these, 11 are compound nouns, and only five are true binomials."

J. Ethnobiol. 3(2):121-137 December 1983

EVALUATING THE STABILITY OF SUBSISTENCE STRATEGIES BY USE OF PALEOETHNOBOTANICAL DATA

DEBORAH M. PEARSALL
American Archaeology Division, University of Missouri
Columbia, Missouri 65211

ABSTRACT.–Two analyses of archaeological plant remains are presented to illustrate how ethnobotanical data can be applied to the problem of determining stability of subsistence strategies through time. An analysis of charred wood from the Real Alto and Rio Perdido sites in coastal Ecuador revels changes in firewood collection strategies which correlate to changes in settlement patterns and land use in the area. An analysis of seed and wood remains from the Pachamachay site, Peru, explores the utility of four quantitative approaches. Patterns of change in occurence of plant taxa are pinpointed within the overall pattern of stability of plant utilization strategies in the puna zone.

INTRODUCTION

Over the past few years, paleoethnobotanists have made an increasing effort to apply their data to questions of cultural process: the evolution of early nutritional systems, cultivation strategies, long term stability of subsistence strategies, and the process of agricultural intensification, among other current research problems in archaeology. Richard Ford (1979), in a recent review of paeloethnobotany in North America, details the evolution of this trend, and the emergence of anthropological ethnobotany. This paper demonstrates the application of ethnobotanical data to the problem of determining the stability of subsistence strategies through time. Two cases will be presented: analyses of charred wood from the Real Alto site, coastal Ecuador (Pearsall 1979), and of charred seeds from the Pachamachay site, Department of Junin, Peru (Pearsall 1980). In each case, ethnobotanical data are available from a series of carbon 14 dated phases, distinguished by ceramic or lithic style. Data independent of the botanical remains exist on subsistence and overall adaptation allowing comparisons between conclusions reached from each set of data. Using several quantitative approaches, it will be demonstrated that even in a case of poor preservation of plant remains valuable insight can be gained by a diachronic examination of paleoethnobotanical data.

Several recent papers (Asch and Asch 1975; Asch, *et al.* 1979; Dennell 1976; Minnis 1981) have emphasized caution in the interpretation of archaeological seed assemblages. The lack of direct correlation between raw seed counts or percentages and dietary importance of the plant is well understood by most ethnobotanists, who routinely include in their analyses cautions about the bias produced by differential preservation of botanical materials archaeologically. A variety of quantitative means have been applied to ethnobotanical data in an attempt to circumvent this problem. No overall review of these measures has been made. No such assessment is attempted herein, rather it is hoped that comment can be generated on this topic by the presentation of the Real Alto and Pachamachay data in several different quantitative formats.

REAL ALTO CHARRED WOOD ANALYSIS

The Real Alto site, excavated under the direction of Donald W. Lathrap, is a 300 x 400 m oval village located on the Rio Verde in southwestern Ecuador. It was occupied by peoples of the Valdivia and Machalilla ceramic traditions. The Valdivia tradition belongs to the early Formative phase of coastal Ecuador (Meggers 1966:34-42). Earliest

Valdivia ceramics, Valdivia I, appear at Real Alto at 3545 B.C. (Damp 1979). The entire sequence, Valdivia I-VIII, is present at the site, but for purposes of this analysis, phases VII and VIII were combined as late Valdivia, terminating at about 1500 B.C. The Machalilla phase, the middle Formative of coastal Ecuador, dates approximately 1500-1000 B.C. The Machalilla samples used in this analysis come from a second site, Rio Perdido (OGCh-20), a multiple component site located near Real Alto and excvated by Ronald D. Lippi. Lippi (1980) proposes a hiatus of several hundred years between the abandonment of Real Alto and the beginning of the Machalilla occupation at Rio Perdido.

The research problem investigated in the full ethnobotanical analysis of plant remains from Real Alto and Rio Perdido was the nature of the subsistence strategy of the Valdivia and Machalilla peoples living in the study area from 3500-1000 B.C., including an investigation of the role of agriculture, the presence of specific crops, such as maize and root crops, and the pattern of firewood and other wild plant utilization (Pearsall 1979). Evidence of maize agriculture, beginning in the earliest Valdivia period, was obtained through phytolith analysis (Pearsall 1978; 1979). Cultivation of a member of the Cannaceae, probably *achira (Canna edulis),* is also suggested by the phytolith data. Charred fragments of *Canavalia* beans, identified by Lawrence Kaplan (Damp *et al.* 1980) as probably domesticated *C. plagiosperma,* also date from earliest Valdivia times onward. A model of Valdivia and Machalilla subsistence developed from the Real Alto study includes not only agriculture, but wild plant gathering, terrestrial hunting, fishing, and collecting of molluscs from mangrove swamps (Pearsall 1979: 186-189).

Charred wood fragments were the only well preserved macroremains recovered in any quantity from the sites. Samples of 20-30 pieces greater than 2.0 mm could be identified from many flotation samples by comparison to modern wood from the region.

Because there was no evidence for structural fire in the areas excavated at Real Alto and Rio Perdido (e.g., no charred posts, no evidence of roofing or wall collapse due to fire), all charred wood could be assumed to be the result of deliberate burning. Small pieces of charred wood were found in concentrations, suggesting cooking areas, and spread in household debris. Stone-constructed hearths were not found at the sites. This situation implies that all charred wood can be considered functionally comparable (also see Miller, 1980). Further, it can be argued that wood charred by deliberate burning is the *one* type of ethnobotanical remain where the archaeological patterning directly translates to a pattern of human behavior (Fig. 1). The charring of wood reflects its function: as a fuel to be burned. By contrast, the charring of most other botanical remains is not the result of its function, but is accidental. Of course, before percentage

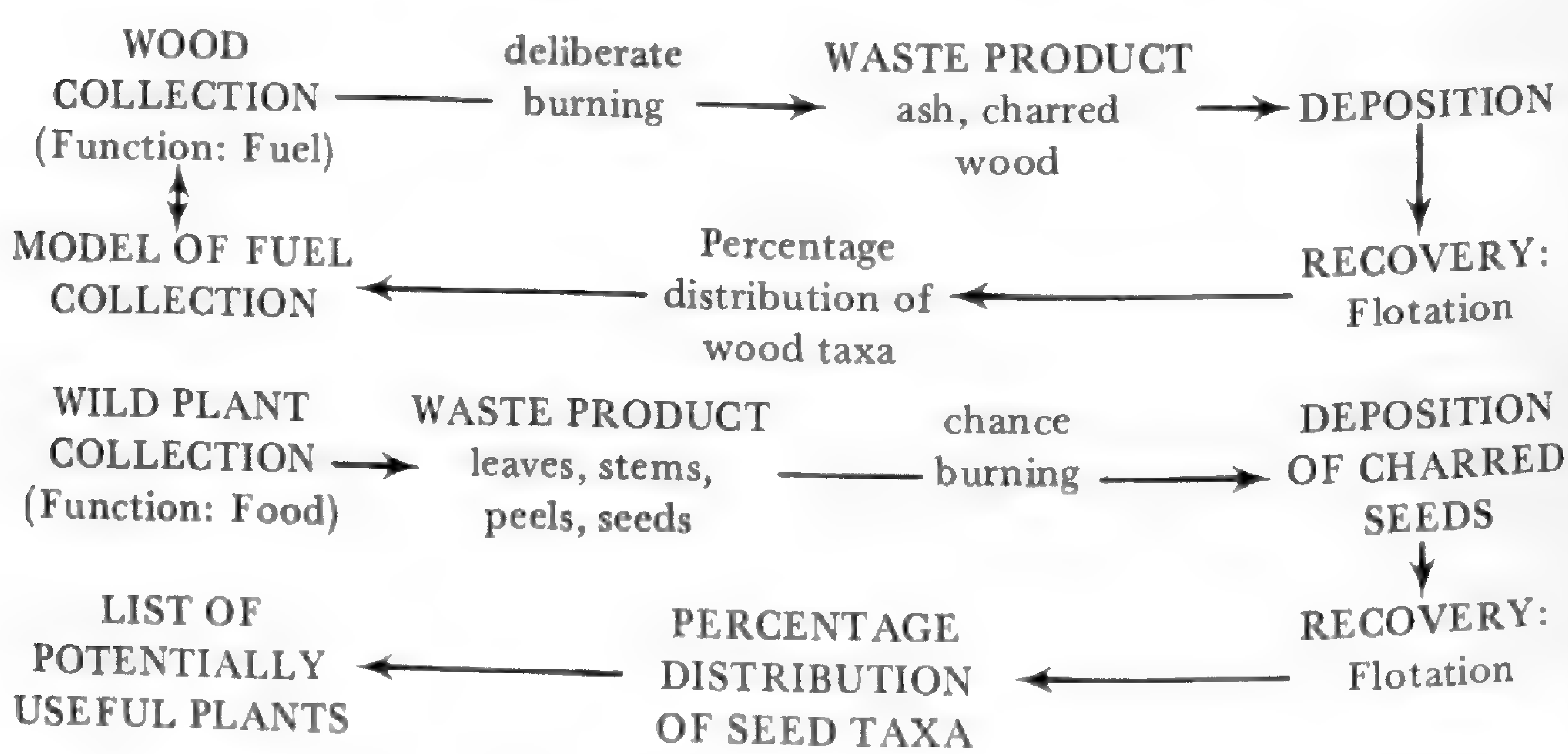


FIG. 1.–Contrast between the results of deliberate burning of wood and accidental burning of seeds in the interpretation of archaeological plant assemblages.

distributions of wood species can be translated into firewood preferences, different fracturing properties, hardness, and ashing properties of the woods, to correct for over- and under-representation in the archaeological record, must be considered. With more experimental work in this direction the potential exists for controlling for these biases, whereas there is little possibility to correct the accidents of seed preservation.

Turning now to the Real Alto analysis, Fig. 2 shows the major vegetation zones of southwestern Ecuador as reconstructed for the early Formative. This reconstruction assumes that the climate during the Valdivia and Machalilla periods (3500-1000 B.C.) was similar to the present day climate of southwestern Ecuador, and controlled by the same patterns of wind and currents which operate today. A critical evaluation of climatic reconstruction curves proposed by Hough (1953), Fairbridge (1961, 1962), McDougle (1967), Sarma (1974) and Byrd (1976) revealed neither convincing evidence for climatic change during the 3500-1000 B.C. period nor evidence that conditions were different from today (Pearsall 1979: 55-79). The description of the floristic communities is based on observations in the area made August 1974 through August 1975, interviews with long-time residents concerning recent man-induced changes, and on the published works of Acosta-Solis (1961, 1968, 1969) and Svenson (1946). Familiarity with two forest communities is necessary for the wood analysis, the xerophytic forest, a dry open formation dominated by leguminous trees, and the seasonally deciduous forest, a denser formation of two stories requiring more abundant and regular rainfall. Both are considered climatic climax vegetation types (Richards 1972:321). The open grassland appearance of much of this area today is secondary grassland formation, caused by man-made disturbance (Pearsall 1979). Both the xerophytic forest and the deciduous forest formations have been modified in composition in modern times because of intensive exploitation,

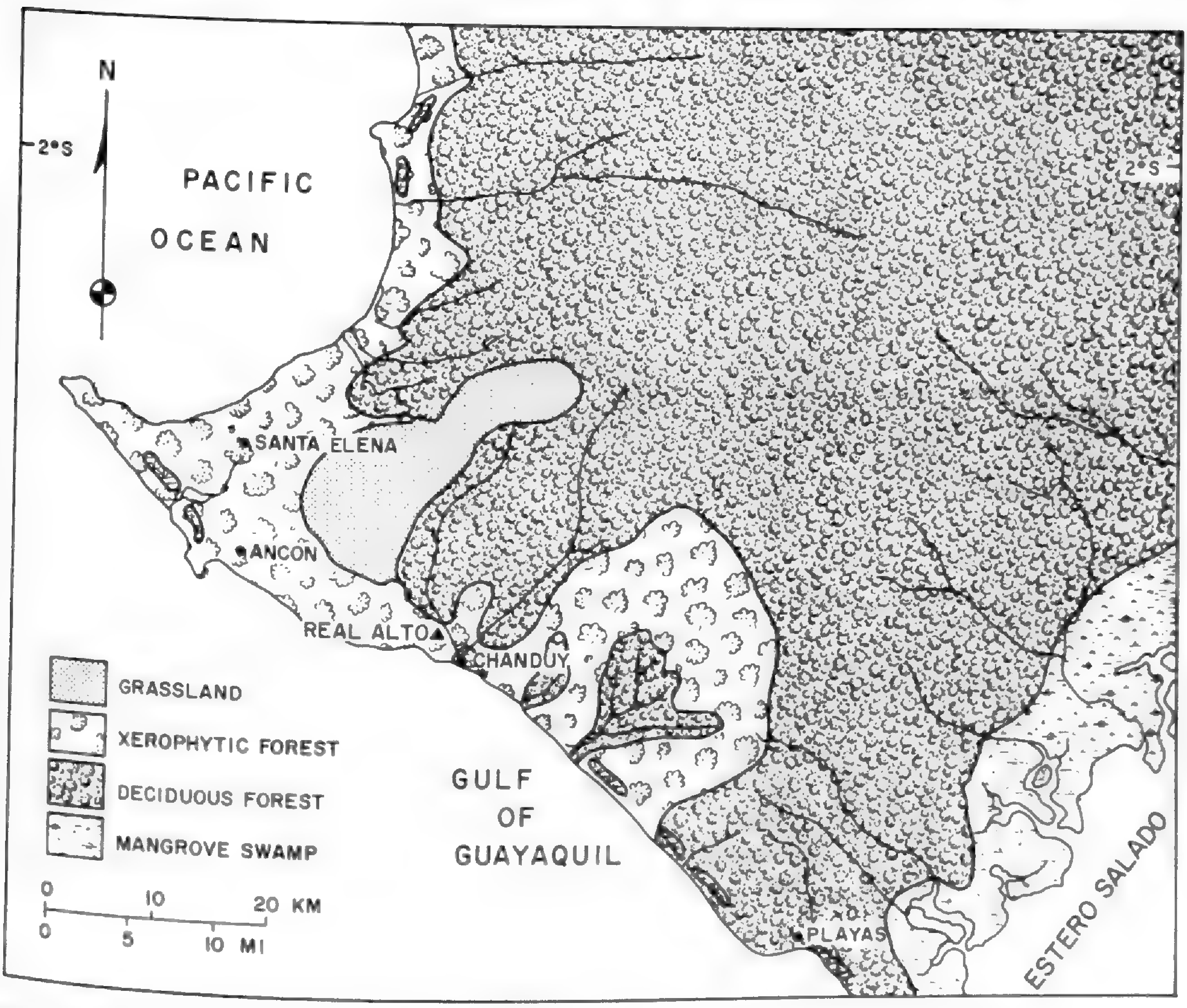


FIG. 2.–Vegetation zones of southwestern Ecuador, ca. 3000 B.C. from Pearsall (1979).

particularly cutting of trees and shrubs, and pulling of dead stumps of previously cut trees, for making *carbón* (locally produced charcoal). The Real Alto and Rio Perdido sites are located near the boundary of the two forest zones.

Seventeen archaeological wood types were defined in this analysis (Table 1).[1] Five of these could be identified securely to species. The other 12 types were either less securely identified, not present in the comparative collection of 75 species, or were similar to more than one species. Types A, C, F, G, I, and J were not similar to any taxon in the collection, and so could not be assigned to habitat. Type H is assigned to the xerophytic forest because it is probably *Maytenus octogona* (L Her.) D.C. Because the archaeological specimens are so few, and minute, this identification is tentative. Type B resembles two taxa: *Triplaris guayaquilensis* H.B.K. and *Tecoma gandichandi* D.C., both native to the deciduous forest. Type D resembles four genera occurring in either deciduous or evergreen forest formations: *Ocotea* sp., *Guazuma ulmifolia* Lamark, *Vitex gigantea* H.B.K., and *Bombax ruizii* Schum. Type E is similar to *Muntingia calabura* L. and two unidentified taxa, all collected in the deciduous forest. Type K is similar to *Dodonaea* sp., a woody vine collected in the deciduous forest of Chongon. This identification is tentative, however, because of the small sizes of the pieces. Because the final unidentified wood type (the soft, grainy type) resembles numerous taxa in the comparative collection, notably many of the large deciduous and evergreen forest trees, it was assigned to the deciduous forest for purposes of this analysis.

TABLE 1.—*Archaeological wood taxa identified at Real Alto and Rio Perdido and their assigned habitats.*

Xerophytic Forest	Deciduous Forest	Unknown Habitat
Prosopis juliflora (S.W.) D.C.	*Stercula corrugata* Little	Type A
Acacia macracantha H. & B.	*Tabebuia chrysantha* (Jacq.) Nicholson	Type C
Pithecellobium dulce (Roscb.) Benth.		Type F
	Type B	Type G
Type H	Type D	Type I
	Type E	Type J
	Type K	
	Soft, grainy Type	

Chi-square analysis of the charcoal data was performed to determine if the 17 wood taxa were randomly distributed among the eight time periods (Valdivia I-VI, late Valdivia, and Machalilla). For this analysis, all taxa and time periods were used, and the wood types having totals less than 10 observations (types G, H, I, J, and K) were combined into the "Other" category. The categories and analysis matrix appears in Table 2. A Chi-square value of 1,416.4 (d.f. = 84) indicates a highly significant difference ($p \ll 0.01$); therefore, the taxa did not appear to be randomly distributed among time periods.

Chi-square analysis was also performed to determine if non-random distributions existed within wood type categories or within time periods. This showed that the Machalilla period accounted for most of the lack of randomness between periods, and the taxa *Prosopis juliflora, Acacia macracantha, Stercula corrugata,* and Types B and E between taxa.

TABLE 2.—Chi square test of wood taxa and time periods. Taxa abbreviations: *Prosopis juliflora* (P.j), *Acacia macracantha* (A.m), *Stercula corrugata* (S.c), *Tabebuia chrysantha* (T.c), and *Pithecellobium dulce* (P.d).

		P.j	A.m	S.c	T.c	P.d	A	B	C	D	E	F	S	Other	Row T.	Row Chi	Sign. Lev.
Val I	Ob.	131	62	0	1	0	7	3	1	0	15	5	1	4	230	55.54	0.001
	Ex.	95.55	56.44	20.56	1.51	2.72	6.45	13.51	4.23	1.31	13.51	5.04	6.85	2.32			
Val II	Ob.	152	29	8	0	5	5	2	6	5	14	20	9	1	256	109.57	0.001
	Ex.	106.35	62.82	22.89	1.68	3.03	7.18	15.03	4.71	1.46	15.03	5.61	7.63	2.58			
Val III	Ob.	455	271	5	3	8	37	44	21	6	76	15	48	7	996	116.00	0.001
	Ex.	413.76	244.42	89.04	6.55	11.78	27.93	58.49	18.33	5.67	58.49	21.82	29.68	10.04			
Val IV	Ob.	25	17	0	0	0	1	1	1	2	4	1	0	0	52	21.26	0.05
	Ex.	21.60	12.76	4.65	0.34	0.62	1.46	3.05	0.96	0.30	3.05	1.14	1.55	0.52			
Val V	Ob.	10	24	1	0	0	1	0	0	0	2	0	0	1	39	32.85	0.01
	Ex.	16.20	9.57	3.49	0.26	0.46	1.09	2.29	0.72	0.22	2.29	0.85	1.16	0.39			
Val VI	Ob.	71	111	1	0	5	10	5	3	0	15	3	2	7	233	102.56	0.001
	Ex.	96.79	57.18	20.83	1.53	2.76	6.53	13.68	4.29	1.33	13.68	5.11	6.94	2.35			
Late Val	Ob.	55	0	2	0	0	0	0	0	0	2	0	5	0	64	64.65	0.001
	Ex.	26.59	15.71	5.72	0.42	0.76	1.79	3.76	1.18	0.36	3.76	1.40	1.91	0.65			
Mach	Ob.	49	46	187	11	9	3	79	10	0	6	6	3	3	412	914.02	0.001
	Ex.	171.16	101.10	36.83	2.71	4.87	11.55	24.19	7.58	2.35	24.19	9.03	12.28	4.15			
Col. Tot.		948	560	204	15	27	64	134	42	13	134	50	68	23	2282	1416.45	
Column Chi		164.19	141.21	749.56	31.72	12.37	13.77	160.16	6.27	23.99	20.44	43.21	34.81	14.75		1416.45	
Sign. Lev.		0.001	0.001	0.001	0.001	0.10	0.10	0.001	0.70	0.01	0.01	0.001	0.001	0.05			

Overall Chi Square= 1416.45, with 84 degrees of freedom, significant at the less than 0.0001 level

This conclusion was drawn by comparing the observed (Ob.) and expected (Ex.) values for the matrix points in the row or column where high Chi square values occurred. For example, much of the deviation from chance giving the high Chi square value for the Machalilla row (914.02), occurs in the P.j, A.m, and S.c points (compare observed and expected values for these taxa).

Fig. 3, showing the percentage distribution of these tax, allows the direction and magnitude of the changes to be seen more easily. Two trends in these data are noteworthy: the replacement of the leguminous tree taxa *(Prosopis* and *Acacia* summed) by taxa of the moister deciduous forest formation *(Stercula* and Type B summed); and the replacement within the leguminous taxa of *Prosopis* by *Acacia.*

Throughout the Valdivia period, wood utilization centered around the leguminous trees of the xerophytic forest. This formation lay to the seaward side of the Real Alto site, providing a close source of firewood. *Prosopis,* the mesquite of the American Southwest, is a highly resinous, hot burning fuel, with a heating value/unit of wood volume 1.4 times that of other woods (Wiley and Manviller 1976:48-51). *Acacia* produces a light brown gum and is very dense. The dead wood from these common, low growing trees is easily collected, a task of children today. The larger deciduous forest trees are very scantily represented in the Valivia samples. The percentages of leguminous taxa may be inflated because of their dense, durable nature. On the other hand, these woods also burn very hot and completely, which might tend in turn to reduce their preservation.

From Valdivia I to VI, a gradual replacement of *Prosopis* by *Acacia* occurs at Real Alto. The late Valdivia samples show a reversal of this tendency, but this may be the

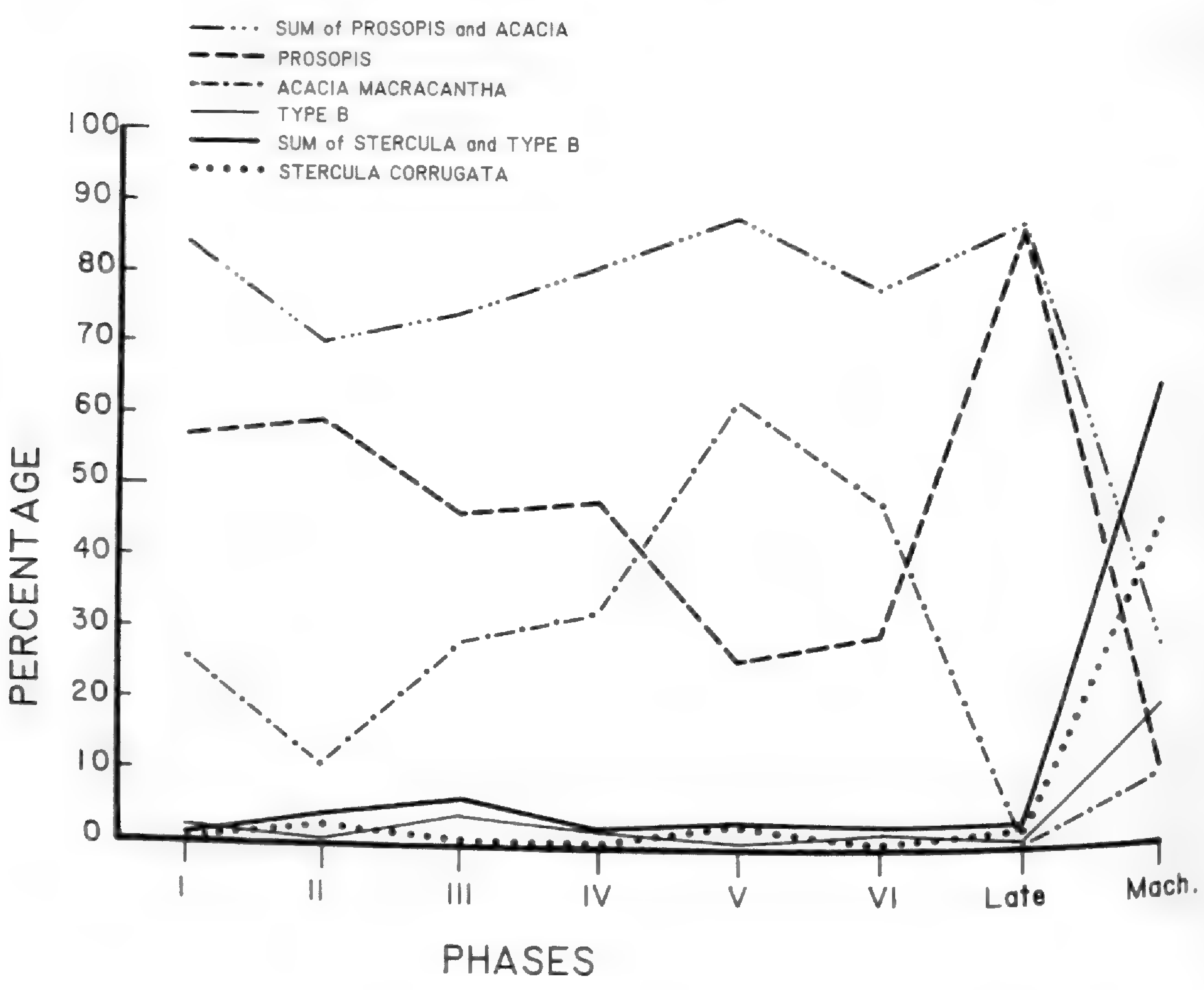


FIGURE 3.–*Percentage distribution of wood taxa, by phase, at the Real Alto and Rio Perdido sites.*

result of small sample size (three features). The replacement of *Prosopis* by *Acacia* could be interpreted as the decreasing availability of the preferred fuel being made up by a less preferred, but similar taxon. Collection pressure would have decreased the availability of *Prosopis*. It can be hypothesized that the Valdivia wood pattern presented here is an example of the maintenance of a traditional fuel system based on collection in the xerophytic forest in the face of declining availability of the best fuel.

In the Machalilla period, striking changes occur. Leguminous tree taxa fall to 23% while 64% of the charred wood belongs to two taxa, *Stercula corrugata* and Type B. *Stercula corrugata* and Type B are both native to deciduous forest. The magnitude of this change suggests that a shift in basic fuel collection strategy has occurred. This hypothesis is supported by other archaeological data, which show in the Machalilla period a spreading of population from a centralized site to small sites along the river course (Zeidler 1977). Localized collecting in the gallery deciduous forest, replacing wide ranging collection in the xerophytic forest, may be the explanation for the shift in the recovered wood remains.

To summarize, this analysis of charred wood from the Real Alto and Rio Perdido sites brings up several points of general interest:

1. A site with poor preservation, i.e., nothing but charred wood, can still yield interesting data on human interaction with the environment.
2. Because patterns in archaeological charcoal closely correspond, though not in exact numbers, to the pattern of use of the resources, the relationship of one taxon to another represents cultural selection.
3. Interpretation of charred wood data, analyzed first to demonstrate areas of statistical differences and then to show the direction and pattern of these changes, can generate hypotheses to be tested against other archeological data and further excavation. In this case it was hypothesized that during the Valdivia period a conservative strategy of collection of hot burning leguminous tree wood from the open xerophytic forest was maintained by substitution of taxa in the face of declining availability of the main taxon. At the end of this period, a change in basic collection strategy occurred, with collection in the deciduous forest replacing the earlier pattern. There is no evidence to support the idea that the deciduous forest expanded in extent during Machalilla times and was therefore more frequently used for firewood collection. Evidence from deep sea cores (Hough 1953; Pearsall 1979; 51-64) suggests that, if anything, the climate during the Machalilla period was slightly cooler and drier than during the Valdivia sequence. Even if it were wetter, there is scarcely time to hypothesize a major vegetation shift. What did shift during the transition from Late Valdivia to Machalilla was the settlement pattern. The greater occurrence of wood from the deciduous forest may represent the burning of scrap wood collected during clearing of the gallery forest for agricultural purposes. The spreading out of the population along the Rio Verde may have necessitated more use of land in the high alluvium area. This need, combined with a decline in the availability of the hot burning leguminous wood through millenia of exploitation, caused the shift in firewood selection.

Finally, it is important to keep in mind, in any ethnobotanical analysis, the sources of error which may affect conclusions drawn from the data. In this study, it was not possible to obtain equally large counts of charred wood for each of the time periods. As is shown in Table 2, the Valdivia IV, V, and Late Valdivia periods had low wood counts. This may have affected the pattern of distribution of charcoal observed in the analysis. Another potential source of error, discussed above, is differential preservation of wood taxa based on their relative hardness.

ANALYSIS OF SEED DATA FROM PACHAMACHAY

The Pachamachay site, excavated by John W. Rick, is a small rock shelter located at just above 4,000 m in the Junin puna of Peru. The Junin puna is an open, rolling grassland with a variety of native plant and animal resources capable of supporting long-term human occupation (Rick 1980:11-28; Pearsall 1980). Occupation at the Pachamachay site is dated by radiocarbon determination from 10,000 B.C. until about A.D. 200 (Rick 1980:64-69). Rick (1980:316-326) defined five preceramic phases (Phases 1-5), with three ceramic phases (Phases 6, 7, and Late), occuring after the preceramic occupation. A model of sedentary, year-round hunter-gatherer occupation of the Junin puna, based on exploitation of camellids, especially vicuna *(Vicugna vicugna),* and of plant and other animal resources, is proposed for the preceramic (Rick 1980:25-28).

Water flotation was used to recover botanical remains from all strata at the site. Only charred remains were preserved. The sheltered location of the site favored charred seed preservation, giving seed counts almost equal to wood counts. Twenty-one taxa of seeds were identified (Table 3), shown here grouped by the zone in which they occur in highest concentration. In general, the dry puna grassland, dominated by bunch grasses (e.g., *Festuca dolichophylla, Calamagrostis recta)* and scattered rosette plants, is the most extensive zone. Where ground moisture levels are higher (lake shores, edges of small streams, depressions) polster-forming taxa (e.g., *Plantago rigida; Distichia muscoides)* and distinct moist area herbaceous taxa occur. Rock outcrops, scattered over the puna, provide a favorable environment for rosettes, tuber-producing species, and small, hardy shrubs (e.g., *Ephedra americana, Margyricarpus strictus).* A number of weedy species occur in disturbed habitats in the zone.

TABLE 3.—*Archaeological seed taxa identified at Pachamachay.*

HABITAT TYPE			
Dry Puna Grassland	Disturbed	Moist (Lakeside)	Rocky
Calamagrostis	*Amaranthus*	*Luzula*	Compositae
Festuca	*Chenopodium*	*Polygonum*	*Euphorbia*
Stipa	*Lepidium*-type Brassicaceae	*Ranunculus*	Leguminosae (other)
Gramineae (other)		*Scirpus*	*Lupinus*
		Sisyrinchium	*Malvastrum*
		Umbelliferae	*Opuntia floccosa* Salm.-Dyck.
			Oxalis
			Plantago

Previous presentation of the ethnobotanical data (Pearsall 1980) relied solely on subjective interpretation to conclude that the constancy of occurrence of taxa through time indicated a stable, puna based collecting strategy virtually unchanged for 10 millenia. These data will be re-examined here, applying several quantitative measures, to better test these conclusions. As discussed above, raw counts or percentages of different seed taxa occurring during a phase or within an individual sample give no direct indication of the relative importance of each taxon. As Asch and Asch (1975) have discussed, however, if context of preservation can be assumed as constant, comparing the variation in occurrence of different plants between assemblages can indicate change in their utilization relative to one another. Can context of preservation be assumed as constant for the eight phases of occupation at Pachamachay? Several factors enter into this evaluation. First, because cave deposits were periodically wet throughout their depth, preservation of dried botanical materials did not occur. Only seeds charred by chance and wood charred as fuel or by accidental burning were preserved. This is a constant. Second, the number of seeds and wood fragments recovered in equal-sized samples from each phase was not constant.[2] Samples from Phases 1-4 have lower quantities of seeds and wood fragments than those from Phases 5 and 6. Phase 7 samples have much higher counts than other samples. Third, cave function, as reconstructed by Rick (1980:293-326), changes to some degree over the period of use of the site. Rick proposes light, sporadic occupation of Pachamachay during Phase 1. Relatively continuous occupation of the shelter began in Phase 2. After an interval of sporadic but intensive use (late Phase 2–early Phase 3), the cave was used as a sedentary base camp until late Phase 5. During Phase 6 and 7 use of Pachamachay as a hunting camp of herders occupying open air lakeshore settlements is suggested, while in the early part of the late ceramic period the cave was used as a ceramic workshop, as indicated by the presence of characteristic clay mixing pits. Taking all these factors into consideration, context of preservation of botanical remains was probably most constant during Phases 1-5, before the cave began to be utilized for activities not involving the whole social unit. Although Phase 1 was a period of less intensive use of the cave, recovery of remains was equal to, or better than, some later phases. Following the discussion of the quantitative analyses applied to the Pachamachay ethnobotanical data, the impact on the results of possible changes in preservation factors in the later phases will be discussed.

The data will be discussed using the following measures: 1) intensity of occupation, measured by the total count of wood in each phase; 2) the percentage distribution of selected seed taxa through time, with intensity held constant by dividing seed count by wood count, 3) species richness or diversity, as measured by the Shannon-Weaver formula and 4) calculation of standard scores, or the number of standard deviation units each taxon varies away from the mean.[3] After first presenting a series of charts showing the results of each approach, these will be compared and conflicts and correlations resulting from their use discussed.

Intensity of Occupation. It has been proposed by several researchers (Asch and Asch 1975; Johannessen 1981a, b), that the total amount of charcoal resulting from deliberate burning can serve as a measure of the intensity of use of an occupation area. An occupation containing a much higher amount of charcoal under conditions of similar preservation and sampling is interpreted as having more intensive cooking or other hearth activity. Fig. 4 shows the charred wood counts through time at Pachamachay. These data were obtained by counting all charred wood fragments greater than 2.0 mm from four flotation samples of equal volume from each phase. It should be noted that length of each phase did not correlate with the amount of charred wood recovered per sample.[4] There are several points of interest in this figure. First, there is a high constancy in the intensity measure for the first four phases of the preceramic, a period of almost 8,000 years. Second, the late preceramic (Phase 5) and the earliest ceramic period (Phase 6) show an increase in occurrence of charred wood relative to the earlier phases, and are similar to each other. Third, Phase 7, the middle ceramic period, shows a marked deviation from the early pattern, with a much higher occurrence of charred wood. In the late ceramic phase, the intensity measure declines, but remains high relative to the earliest six phases.

Percentage Distribution of Selected Seed Taxa. Several authors (Asch and Asch 1975; Johannessen 1981a, b) measure the percentage occurrence of taxa within an assemblage relative to wood count, rather than total seed count. This serves to hold intensity of occupation constant, so that the occurrence of the seed taxa can be compared between assemblages. Fig. 5 shows seed/wood ratios for eight seed taxa considered food resources, and the Gramineae, considered here to represent thatch or fuel resources. With intensity of occupation held constant, several interesting patterns emerge. First, *Opuntia* declines in overall abundance through time. Decline occurs between Phases 1-3 and between

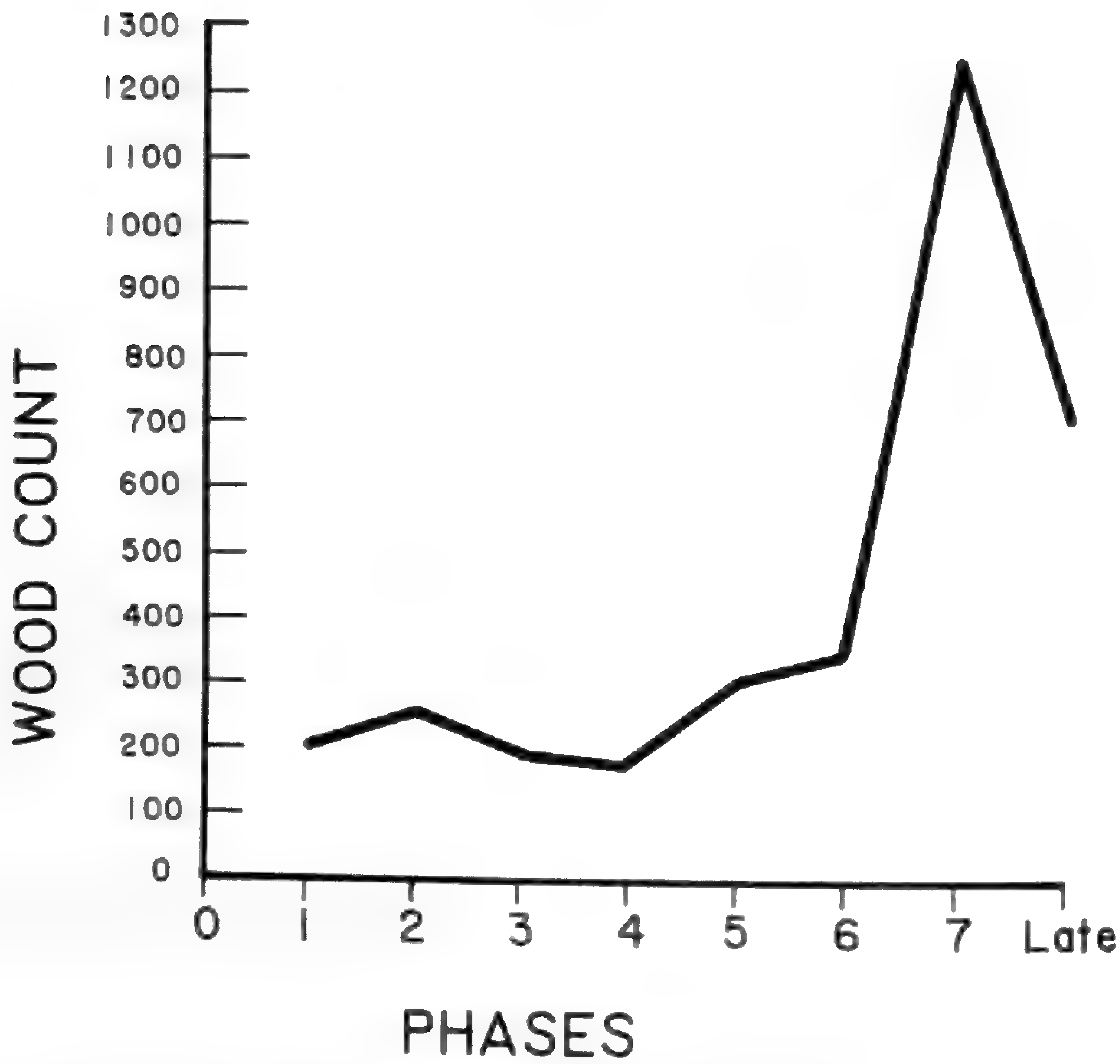


FIG. 4.–Intensity of occupation, by phase, at Pachamachay

Phases 5-7, with a sharp resurgence in Phase 4, the middle preceramic. *Chenopodium* increases from Phases 1-3, while *Lupinus*, other legumes, and lakeside plants, *Scirpus*, *Sisyrinchium*, and *Luzula* stay fairly constant in Phases 1-3. Second, *Amaranthus*, *Chenopodium*, lakeside plants, and legumes all reach their greatest relative abundance in either Phases 5 or 6, the late preceramic and early ceramic phases. Third, all seed taxa considered food resources decline in Phase 7. By contrast, the grasses (black), declining from Phases 1-4, increase through Phase 7, reaching their highest peak there. These parameters are difficult to depict graphically because of the wide range of variability present.

Species Richness or Diversity. Species diversity is a measure that takes into account both the total number of species or taxa present in a population, and the abundance of each species (Pielou 1969:221-235). High diversity results when a large number of species are evenly distributed, i.e., when it would be difficult to predict what a randomly selected item would be. Low diversity results when the number of species present is low, or when abundance of each is highly variable. Since ethnobotanical data deal both in numbers of species and counts of each, combining these into one index, diversity, may be useful. Yellen (1977) used the Shannon-Weaver information index (Shannon and Weaver 1949) as a diversity measure, and demonstrated that a !Kung base camp had a higher diversity index than a specialized activity area. In the !Kung study, each kind of debris encountered in an abandoned campsite (porcupine bones, nut-cracking stones, etc.) was equated to an individual species. The amount of each kind of debris was then equal to the abundance of that species (Yellen 1977:101-108). It is important to note that the Shannon-Weaver index is a poor measure when abundance of species is low (Pielou 1969:231-233). In the Pachamachay data, even with 4 samples per period combined, many seed counts were less than 10. Rather than artificially lump species to raise counts, the Shannon Weaver index is presented uncorrected here as an example of this approach (Fig. 6). Phases 1-3 show marked constancy of diversity. The index rises somewhat in Phase 4. The highest diversity is achieved in Phase 5, the late preceramic. The earliest ceramic

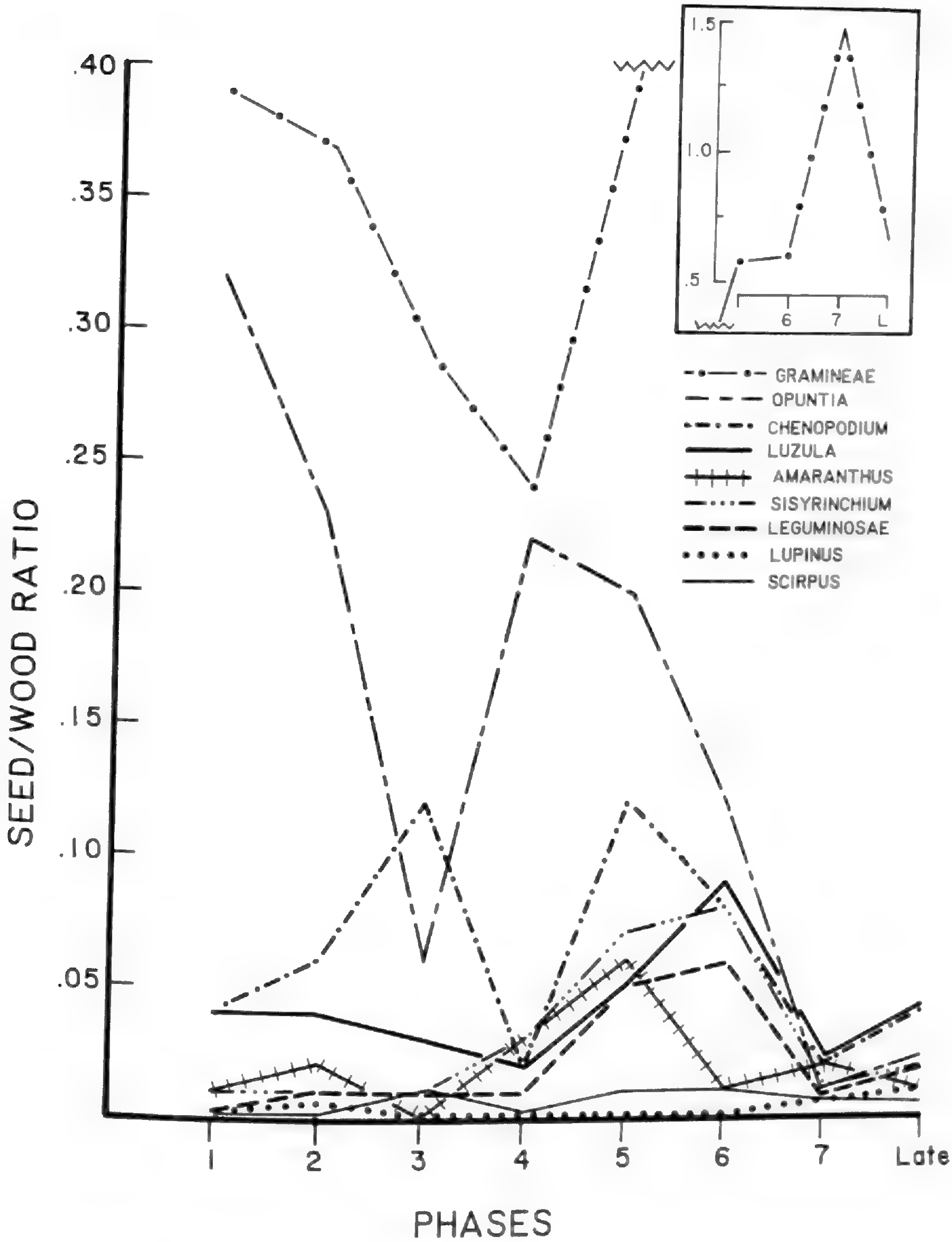


FIG. 5.–Percentage distribution of seed taxa, by phase, at Pachamachay with intensity of occupation held constant.

phase, Phase 6, has a diversity index similar to Phase 5. There is a dramatic drop in diversity in Phase 7. Inspection of the Phase 7 data reveal that very high counts of grass seeds, i.e., a lack of evenness in the data, account for the low diversity index for this period. Diversity goes back up to earlier levels in the late ceramic phase.

Standard Scores. Another attempt to convert raw seed counts to a more useable form was made by converting the data to standard scores, or the number of standard deviation units each taxon varied away from the mean. This procedure involved finding the mean count of each species through time, calculating the standard deviation of each species, and then calculating for each occurrence of each species the number of standard deviation

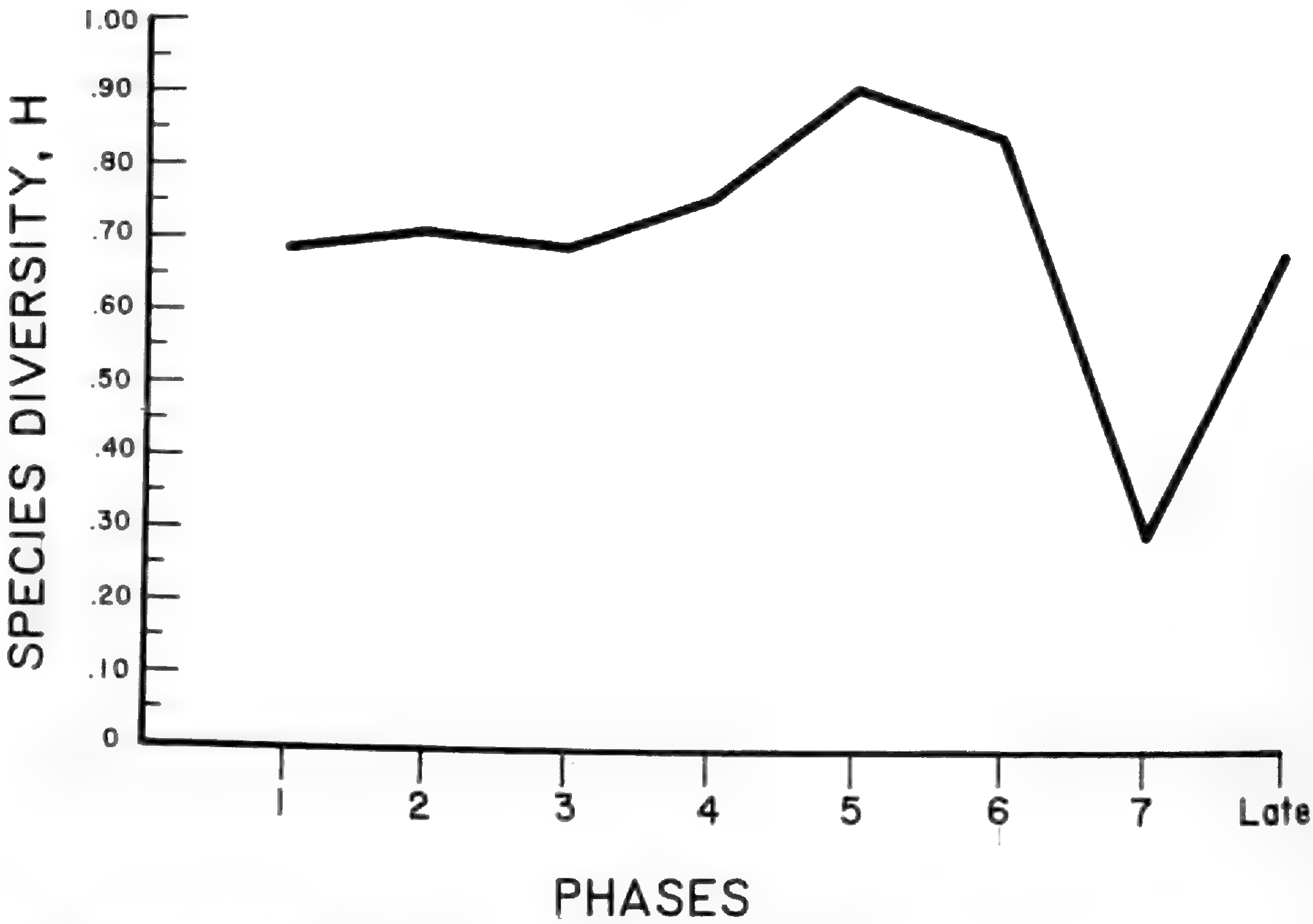


FIG. 6.—Species richness or diversity, by phase, for Pachamachay seed taxa.

units, or Z, of each count away from the mean (Blalock 1972:80-101). These standard scores can then be examined as data points instead of the raw counts. This reduces the impact of absolute quantities, and evens out insignificant differences. Similarities in the direction of changes obscured by different absolute counts can be more easily seen.

Fig. 7 shows the standard scores of all taxa possibly used for food except *Oxalis* (1 seed). Again, for the purposes of this analysis, it is assumed that most grass seeds represent accidental burning of thatch, or inclusion of seeds in camellid dung used as fuel. Except for *Opuntia* cactus, and possibly *Chenopodium*, all taxa show a similarity in variation during the first 4 preceramic phases. All occur below the mean and vary relatively little in their standard score from phase to phase. Similarly, most taxa occur above the mean in the later half of the sequence. Variation is no longer even, however. Two clusters of high positive deviation occur in Phases 5 and 6. All taxa except *Amaranthus* then decline in Phase 7. The late ceramic phase is very variable.

Looking at the fuel or thatch plants (Fig. 8), there is little variation in occurrence of these taxa in Phases 1-4. This pattern continues into Phase 5, with the exception of a sharp positive rise in standard score for Compositae and *Stipa*. In Phase 6, all scores except *Calamagrostis* approach the mean. Phase 7 shows a cluster of high positive scores. While the potential food plants showed peaks of high positive standard scores in Phases 5 and 6, late preceramic and early ceramic, most fuel or thatch taxa clustered highly positive in Phase 7. Both groups of plants exhibited little variation in standard scores during Phases 1-4. The exception to this was *Opuntia*, which deviated from all other species, occurring above the mean early in the occupation and below the mean during later phases.

To summarize, these four quantitative approaches to the Pachamachay seed data suggest the following:

1. There was agreement in all measures employed for a high degree of constancy during preceramic Phases 1, 2, 3, and 4, or from 10,000-2200 B.C. It is hypothesized that a longterm, stable strategy of utilization of local puna resources existed. The relative

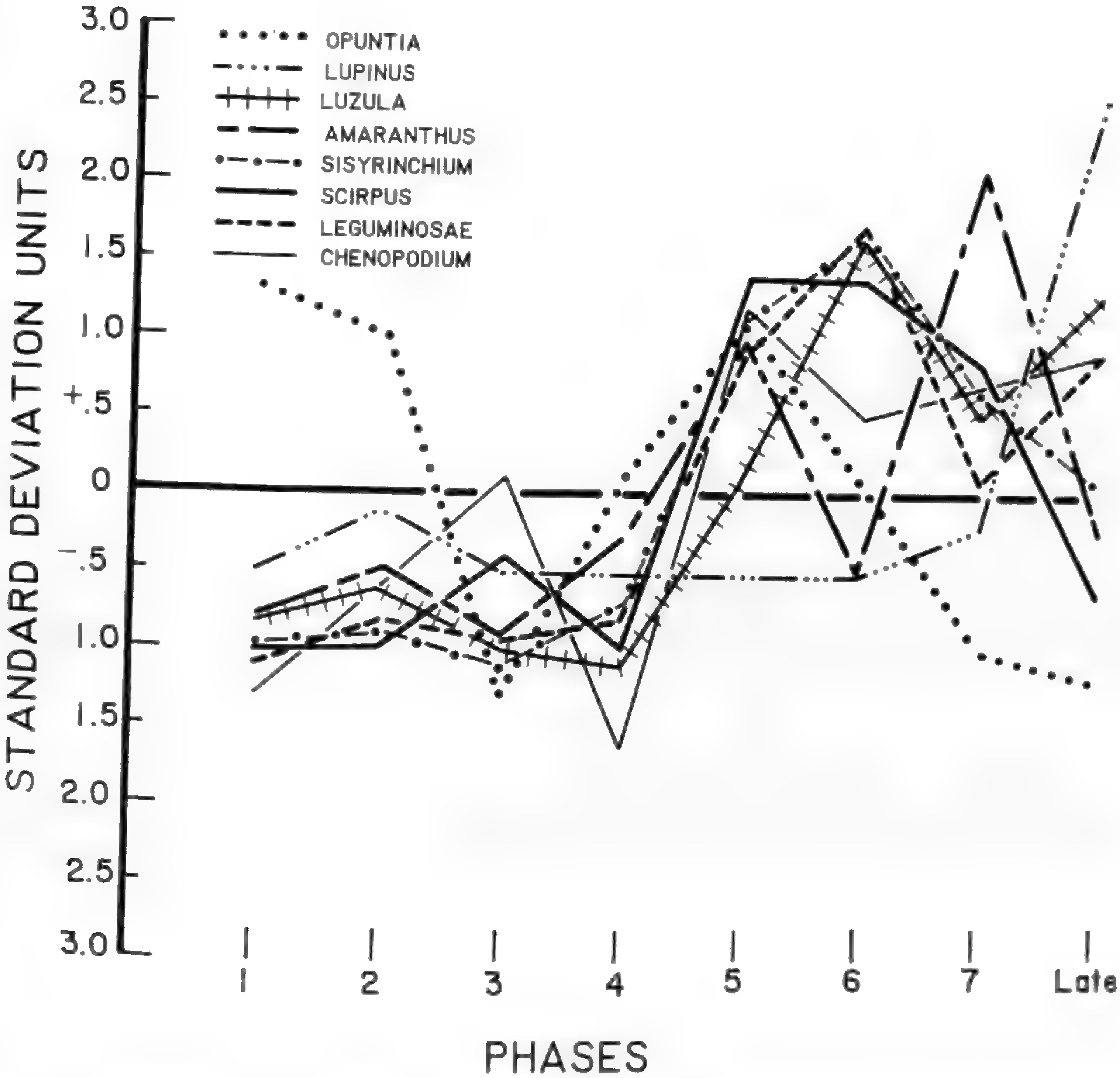


FIG. 7.–Occurrence of taxa with edible seed, by phase, at Pachamachay, expressed as the number of standard deviation units from the mean.

importance of each taxon is difficult to conclude, but the variation in *Opuntia*, running contrary to most other taxa, suggests a declining role for this wild food.

2. All measures indicate a change in direction in the late preceramic period, (Phase 5) and similarity between Phase 5 and Phase 6, the earliest ceramic phase. The occurrence of most foods, measured by standard score or percentage occurrence, peak in either Phase 5 or 6, or are high in both. There is increased variability in seed occurrence as a whole.

3. Phase 7 is also marked by abrupt changes in most of the measures. A dramatic drop in species diversity occurs, corresponding to low occurrences of edible plants and the high occurrence of fuel and thatch plants. Even with the caution that low abundance counts were used to calculate this measure, a change in the function of the site seems to be indicated. The rise in the amount of charred wood present in Phase 7 suggests a function related to increased burning.

How do these results correlate with the non-botanical data from Pachamachay? Intensity of occupation of the cave and the nature of that occupation changed over the period of use of the site (Rick 1980:293-326). Intensity was low in Phase 1, followed by intense occupation in Phase 2. After a decrease of intensity at the end of Phase 2–early Phase 3, intensity of occupation rose again until a final decline from late Phase 5 onward.

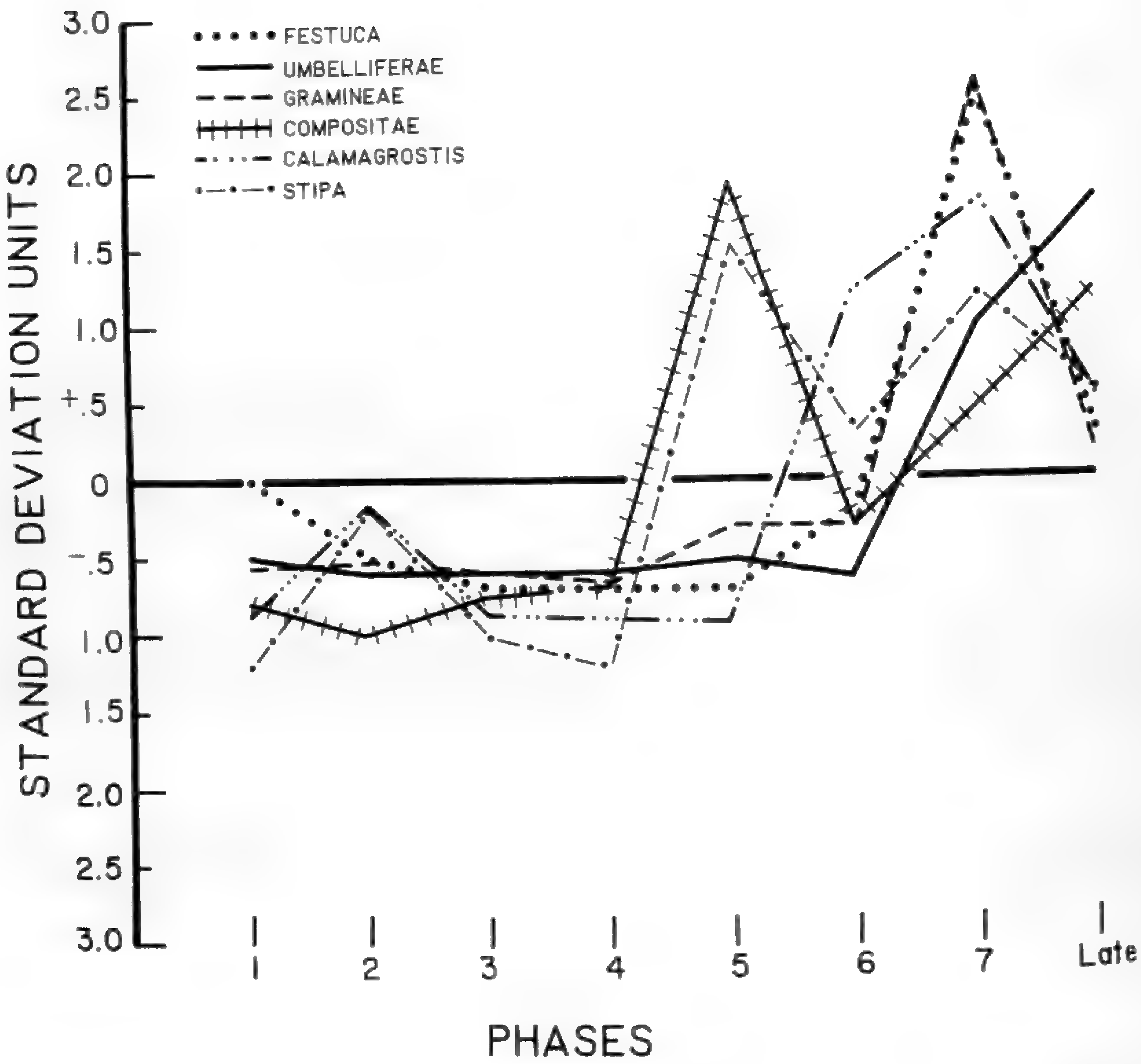


FIG. 8.—Occurrence of fuel and thatch taxa, by phase, at Pachamachay, expressed as the number of standard deviation units from the mean.

As a measure of intensity of occupation, wood count per phase (Fig. 4) does not reflect this pattern. The lower intensity of Phase 1 is not detected, intensity does not rise appreciatively from Phase 2 to Phase 5, nor decline in the later phases. The species diversity measure (Fig. 6) correlates better with Rick's data on intensity of occupation, showing increases in Phases 4 and 5, and declines in Phases 6 and 7. Phase 1 is not distinguished from the other phases, however. If low abundance could be corrected for, this measure may have considerable potential for distinguishing the botanical remains of a base camp from those of a temporary or special activity camp.

The occurrence through time of individual taxa as measured by standard score or percentage occurrence, show patterns which do not parallel the data on intensity of occupation at Pachamachay. The basic assemblage of subsistence plants changes little from Phases 1-4, even with increasingly intense occupation. This finding supports the conclusions of the initial study (Pearsall 1980), that a stable, puna-based collecting strategy was in operation through the millenia at the site. The transitional nature of Phases 5 and 6, obscured in this analysis somewhat because of lumping of levels, is expressed by increasing variability and high occurrence of some edible taxa. It seems clear that change or lack of change in the occurrence of specific taxa is dependent on other factors than intensity of occupation.

Because the "hard" archaeological data suggest changes in the nature of human use of the cave during Phases 6, 7, and the Late Ceramic Period, conditions leading to the charring and preservation of seeds and wood also could have changed. For example, if the hunting parties occupying the shelter during Phases 6 and 7 were small, and spent little time actually in the cave, the remains of their camp fires or cooking fires might have been covered over before the next occupation, giving better preservation of remains than when the cave was used on a daily basis. This might be part of the explanation for the higher quantities of wood and seeds in samples of the later phases (see Note 2). Occurrence of individual seed types could also be affected by such factors.

CONCLUSIONS

An attempt has been made to apply ethnobotanical data to the problem of determining the stability of subsistence strategies through time. The two cases discussed had well dated and analyzed "hard" archaeological data which could be used to evaluate the hypotheses generated from the perishable botanical data. Several different quantitative measures of seed occurrence could also be tested. Both the Real Alto charred wood analysis and the Pachamachay seed analysis illustrate the potential of these data in giving valuable insight into subsistence patterning through time. The application of archaeological plant data to questions of cultural process is an exciting direction for paleoethnobotany, and one with great potential.

To take full advantage of this potential, however, ways must be found to analyze ethnobotanical data to minimize the vagaries of preservation. The quantitative measures applied in this study attempt this, with varying success. Of the measures applied in the Pachamachay seed analysis, using standard scores to replace counts or percentages as data points seems to have considerable potential for indicating direction and magnitude of changes, while minimizing the impact of absolute quantities. This technique also allows clear graphic presentation of results. Use of a species diversity measure, such as the Shannon-Weaver information index, minimizes the impact of any particular set of data by combining all data from one time period into one index. Of course, information on the behavior of the constituent data sets is also lost. It is argued that use of percentage occurrences in wood analysis, or absolute counts, if sample sizes can be held constant, can give direct information on cultural selection of wood (see Fig. 1). Over or under-representation of specific taxa due to differential burning characteristics could be corrected by experimental work.

ACKNOWLEDGEMENTS

I thank Donald W. Lathrap for the opportunity to work at the Real Alto site and John W. Rick for the chance to analyze the Pachamachay data. Figures 3-8 were drawn by Susan J. Vale. I also thank Michael Trimble, Michael O'Brien, Robert Benfer, and anonymous reviewers for their suggestions and comments. I alone bear responsibility for errors in identification and interpretation. An earlier version of this paper was presented at the 46th Annual Meeting of the Society for American Archaeology, San Diego.

LITERATURE CITED

ACOSTA-SOLIS, MISAEL. 1961. Los bosques del Ecuador y sus productos. Editorial Ecuador, Quito, Ecuador.

———. 1968. Las Divisiones fitogeográficas y las formaciones geobotánicas del Ecuador. Editorial Casa de la Cultura, Quito, Ecuador.

———. 1969. Glumifloras del Ecuador. Instituto Ecuatoriano de Ciencias Naturales, No. 71, Quito, Ecuador.

ASCH, DAVID L., KENNETH B. FARNSWORTH, and NANCY B. ASCH. 1979. Woodland subsistence and settlement in west central Illinois. Pp. 80-85, *in* Hopewell archaeology (D.S. Brose and N'omi Greber, eds.), Midcont. J. Archaeol. Spec. Pap. 3, Kent State Univ. Press, Kent State, Ohio.

ASCH, NANCY BUCK and DAVID L. ASCH. 1975. Appendix V. Plant remains from the Zimmerman site - grid A. A quantitative

LITERATURE CITED (continued)

perspective. Pp. 116-120, *in* The Zimmerman site: further excavations at the Grand Village of Kaskakia. Margaret Kimball Brown. Illinois State Mus., Springfield, Rep. Invest., No. 32.

BLALOCK, HUBERT M., JR. 1972. Social statistics. Second edition (1960). McGraw-Hill, New York.

BYRD, KATHLEEN MARY. 1976. Changing animal utilization patterns and their implications: southwest Ecuador (6500 B.C. - A.D. 1400). Unpubl. Ph.D. dissert. (Anthr.), Univ. of Florida, Gainesville.

DAMP, JONATHAN EDWARD. 1979. Better homes and gardens: the life and death of the early Valdivia community. Unpubl. Ph.D. dissert. (Archaeol.), Univ. Calgary., Calgary, Canada.

__________, DEBORAH M. PEARSALL and LAWRENCE T. KAPLAN. 1981. Beans for Valdivia. Science 212:811-812.

DENNELL, R.W. 1976. The economic importance of plant resources represented on archaeological sites. J. Archaeol. Sci. 3(3): 229-249.

FAIRBRIDGE, RHODES W. 1961. Eustatic changes in sea level. Pp. 99-185, *in* Physics and chemistry of the earth, Vol. 4, (L.H. Ahrens, F. Press, K. Rankania and S.K. Runcorn, eds.), Pergamon Press, New York.

__________. 1962. World sea level and climate changes. Quaternaria (Roma) 6:111-134.

FORD, RICHARD I. 1979. Paleoethnobotany in American archaeology. Pp. 286-336, *in* Advances in archaeological method and theory. Vol. 2, (Michael B. Schiffer, ed.). Academic Press, New York.

HOUGH, JACK L. 1953. Pleistocene climatic record in a Pacific Ocean core sample. J. Geol. 61:252-262.

JOHANNESSEN, SISSEL. 1981a. Appendix A: Plant remains from the Sandy Ridge farm site (11-S-660). Pp. 18-23, *in* Final report on archaeological investigations at the Sandy Ridge farm site (11-S-660). FAI-270 Archaeological Mitigation Project Report, No. 20. Univ. Illinois, Urbana.

__________. 1981b. Floral resources and remains. Pp. 120-130, *in* The Dryoff-Levin site: A Late Archaic occupation in the American Bottom. Thomas E. Emerson. FAI-270 Archaeological Mitigation Project Report, No. 24., Univ. Illinois, Urbana.

LIPPI, RONALD. D. 1980. The Machalilla phase from an inland perspective. Paper presented at the 8th Annual Midwest Conference on Andean and Amazonian Archaeology and Ethnohistory. Madison, Wisconsin. Unpubl. Ms. deposited with the author.

McDOUGLE, EUGENE J. 1967. Water use and settlements in the changing environments of the southern Ecuadorian coast. Unpubl. Master's essay, (Anthr.). Columbia Univ., New York.

MEGGERS, BETTY J. 1966. Ecuador. Praeger, New York.

MILLER, NAOMI F. 1980. Paleoethnobotanical studies at Malyan: the use of wood as fuel. Paper presented at the 45th Annual Meeting of the Society for American Archaeology, Philadelphia. Unpubl. Ms. deposited with the author.

MINNIS, PAUL E. 1981. Seeds in archaeological sites: sources and some interpretive problems. Amer. Antiq. 46(1):143-152.

PEARSALL, DEBORAH M. 1978. Phytolith analysis of archeological soils: evidence for maize cultivation in Formative Ecuador. Science 199:177-178.

__________. 1979. The application of ethnobotanical techniques to the problem of subsistence in the Ecuadorian Formative. Ph.D. dissert. (Anthr.), Univ. Illinois. Univ. Microfilm, Ann Arbor, Michigan.

__________. 1980. Pachamachay ethnobotanical report: plant utilization at a hunting base camp. Pp. 191-231, chapter 9 *in* Prehistoric hunters of the High Andes. John W. Rick. Academic Press, New York.

PIELOU, E.C. 1969. An introduction to mathematical ecology. John Wiley and Sons, New York.

RICHARDS, P.W. 1972. The tropical rain forest: an ecological study. Fourth edition (1952). Cambridge Univ. Press, Cambridge.

RICK, JOHN W. 1980. Prehistoric hunters of the High Andes. Academic Press, New York.

SARMA, A.V.N. 1974. Holocene paleoecology of south coastal Ecuador. Proc. Amer. Philos. Soc. 118(1):93-134.

SHANNON, C.E. and W. WEAVER. 1949. The mathematical theory of communication. Univ. Illinois Press, Urbana.

SVENSON, H.K. 1946. The vegetation of the coast of Ecuador and Peru and its relation to the Galapagos Islands. Amer. J. Bot. 33:394-498.

WILEY, A.T. and F.G. MANWILLER. 1976. Market potential of mesquite as fuel. For. Prod. J. 26(9):48-51.

YELLEN, JOHN E. 1977. Archaeological approaches to the present: models for re-

LITERATURE CITED (continued)

constructing the past. Academic Press, New York.

ZEIDLER, JAMES A. 1977. Early Formative settlement in the Chanduy Valley, southwest Ecuador. Paper presented at the 42nd Annual Meeting of the Society for American Archaeology, New Orleans. Unpubl. Ms. deposited with the author.

NOTES

[1]Charred wood was identified from both flotation samples and carbon samples (samples collected during excavation). In samples where charred wood was abundant, a minimum of 20 pieces were selected at random for identification. For samples with little wood present, all pieces roughly 2 mm or larger were identified. Number of samples examined per phase: I 10; II 10: III 28; IV 9; V 2; VI 9; Late 5; Mach. 4. Total wood count: 2282 pieces.

[2]Four general level flotation samples per phase were used for this analysis. Counts of identified seeds and all charred wood fragments were as follows:

	Seeds	Wood		Seeds	Wood
Phase 1	196	199	Phase 5	433	302
Phase 2	211	253	Phase 6	434	332
Phase 3	112	196	Phase 7	2046	1227
Phase 4	117	182	Late	719	711

Total seeds: 4268; total wood: 3402

[3]Measures employed in this analysis were calculated as follows: *Intensity of Occupation:* Total count of charred wood, summed by phase. *Percentage Distribution of Seed Taxa, Intensity of Occupation held Constant:* Seed count of each taxon, summed by phase, divided by total wood count, summed by phase.

Species Richness or Diversity: The Shannon-Weaver Information Index for finite populations (H) was calculated for each phase.

$$H = -\Sigma \left(\frac{N_j}{N}\right) \ln \left(\frac{N_j}{N}\right)$$

N: total number of seeds in the phase

ln: natural log

N_j: total number of seeds of $taxon_j$ in the phase

Taking the Phase 1 calculation as an example: N = 196 seeds, 12 taxa. The product $\left(\frac{N_j}{N}\right) \ln \left(\frac{N_j}{N}\right)$ was calculated for each seed taxon.

For example, *Opuntia:* $\frac{64}{196} \ln \frac{64}{196} = -0.16$

H equals the negative sum of the 12 products, or 0.69.

Standard Deviation Units, Z (Standard Scores)

$$Z = \frac{x - \bar{x}}{s}$$

$\bar{x}$; occurrence of a seed taxon in a phase

x: mean occurrence of a taxon in all phases

s: standard deviation of a taxon from the mean

The standard score, Z, was calculated for each taxon in each phase, and used as a datum point on the graphs.

[4]To insure that the amount of wood present per phase was not just a function of the length of each phase, wood counts were graphed versus length of phases, in years. No correlation was found. For example, Phases 1, 3, and 4, which have almost equal wood counts (199, 196, and 182 pieces, respectively) vary in estimated length from 3000 to 800 years.

J. Ethnobiol. 3(2):139-147 December 1983

RICHARD SPRUCE: AN EARLY ETHNOBOTANIST AND EXPLORER OF THE NORTHWEST AMAZON AND NORTHERN ANDES

RICHARD EVANS SCHULTES
Jeffrey Professor of Biology and Director, Botanical Museum of Harvard University, Cambridge, Massachusetts 02138

ABSTRACT.—Although Richard Spruce, a pioneer botanical explorer of the northwest Amazon and the northern Andes in the middle of the last century, made numerous important ethnobotanical discoveries, he missed the opportunity of delving deeply into the ethnopharmacological lore of the area. Part of this deficiency was due not certainly to his scientific curiosity but to his inability to associate closely with unacculturated natives, the incredible intensity of his floristic and taxonomic studies, and possibly to his illness. Yet his research set the stage for recent ethnobotanical investigations of this very species-rich region.

INTRODUCTION

The Indians of the northwest Amazon, especially those of the Brazilian and Colombian region of the Río Vaupés, have a rich ethnopharmacological lore. This wealth of knowledge of the presumed medicinal properties of plants, however, is just coming to the fore—and most certainly not too soon with its disappearance in the face of advancing acculturation and the inroads of civilization.

Richard Spruce (Fig. 1), the British plant-explorer who opened up this region to science between 1851 and 1854, must be counted amongst the greatest naturalists ever to have engaged in collecting and studies anywhere in virgin tropical American territories. As a result of his meticulous observation and insatiable curiosity, a basis for our understanding of great areas of the Amazon Valley and of the northern Andes was early and most firmly laid. Not only did Spruce advance taxonomy and floristics, but he also made many important observations in ethnology, linguistics and geology. Some of the most significant discoveries in connection with the hallucinogens derived from *Banisteriopsis Caapi* (Fig. 2) and *Anadenanthera (Piptadenia) peregrina* (Fig. 3-5) are due to his first-hand field observations. And he was particularly interested in ethnobotanical lore concerning the palms.

ETHNOBOTANICAL OBSERVATIONS AND CONTRIBUTIONS BY RICHARD SPRUCE

It has always been difficult for me to understand how several very important ethnobotanical discoveries eluded such a perspicaceous scientist who spent four years on the Rio Negro and its tributaries. The use of *Virola* in the preparation of an hallucinogenic snuff provides a good example. Spruce gave special attention to this myristicaceous genus and collected the material on which at least nine new species were described. Although he was definitely interested in and had personal contact with several hallucinogenic plants, he failed to learn that the Indians employed the red bark-"resin" of *Virola* in elaborating a snuff used by medicine men and, in some tribes, by the whole male population.

Another curious aspect of Spruce's ethnobotanical observations was his failure to discover "simples" that were employed medicinally by Indians of the northwest Amazon. "The Indians," he says, "have a few household remedies, but by far the greater portion of these have come into use since the advent of the white man from Europe and the negro

FIG. 1.–Richard Spruce. Drawn by Elmer W. Smith from a photograph in the Gray Herbarium, Harvard University, taken before Spruce left for South America.

from Africa. Von Martius remarks nearly the same thing in the introduction to his Systema Materiae Medicae Vegetabilis Brasiliensis (1843, p. xvii).

> . . . Of external applications, I have seen only the following. For a wound or bruise or swelling, the milky juice of some tree is spread thick on the skin, where it hardens into a sort of plaster, and is allowed to remain on until it falls of itself. Almost any milky tree may serve, if the juice be not acrid; but the Heveas (India-rubbers), Sapotads, and some Clusias are preferred. Such a plaster has sometimes an excellent effect in protecting the injured part from the external air.

This experience of Spruce's is difficult to reconcile with my own observations during the past 40 or more years amongst the many tribes along the Colombian Ríos Vaupés, Apaporis and Caquetá and their tributaries–a region with a flora estimated at 80,000 species–where I collected large numbers of plants reputedly valuable alone or in prescriptions for treating a variety of common diseases.

It is true that, in this whole region, the "medicines" *par excellence*–and those which are administered not to the patient but usually to the medicine-man–are the hallucinogens. The "medicine" with psychic properties that enables the medicine-man easily through hallucinations to see or converse with malevolent spirits from whom come all illness and death are usually far more important in native cultures than those medicines

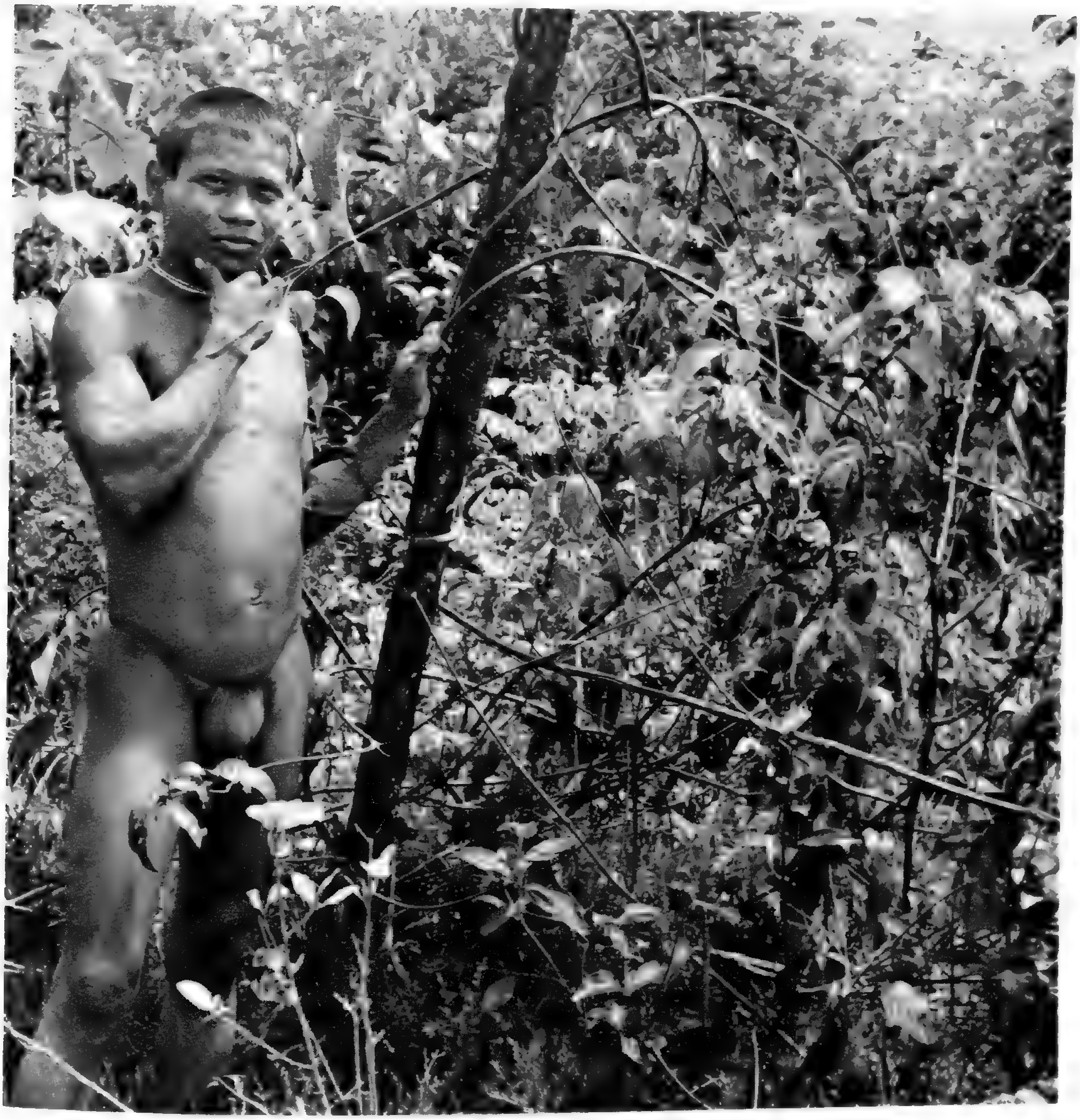


FIG. 2.–Cultivated vine of the caapi plant, *Banisteriopsis Caapi*, identified by Richard Spruce as the source of an hallucinogenic drink prepared throughout the western part of the Amazon Valley in Brazil, Colombia, Ecuador and Peru. Photograph: R. E. Schultes.

with purely physical properties. It is, however, most certainly untrue that the Indians of the northwest Amazon denegrate or do not possess those medicinal plants which have properties physically to reduce pain or suffering, lessen uncomfortable symptoms of illness or even apparently cure pathological conditions. They have many such medicinal plants and are willing to share their knowledge with the serious, enquiring visitor. It is not only I who has found these people to possess a deep knowledge of medicinal plants; other botanists and several anthropologists have likewise been impressed with the wealth of native medical folk lore in the region.

Spruce's surprising statements concerning the lack of knowledge and use of medicinal plants in the northwest Amazon may be explained by his difficulty in spending long periods of time with aboriginal peoples. We must always remember that Spruce was at work well over a century ago. He wrote:

> I have never been so fortunate as to see a genuine payé (medicine-man) at work. Among the civilized Indians, the Christian padre has supplanted the pagan payé . . . With the native and still unchristianized tribes, I have for the most part held only passing intercourse during some of my

FIG. 3.–Tree of *Anadenanthera peregrina.* Photograph: R. E. Schultes.

> voyages, Once I lived for seven months at a time among them, on the river Uaupés, but even there I failed to catch a payé. When I was exploring the Jauarité cataracts on that river, and was the guest of Uiaca, the venerable chief of the Tucano nation, news came . . . that a famous payé . . . would arrive that night and remain until next day, and I congratulated myself on so fine a chance of getting to know some of the secrets of his 'medicine' . . . When he learnt that there was a white payé (meaning myself) in the village, he and his attendants immediately threw back into the canoe his goods, which they had begun to disembark, and resumed their dangerous voyage down the river in the night-time. I was told he had with him several palm-leaf boxes, containing his apparatus . . . I could only regret that his dread of a supposed rival had prevented the interview which to me would have been full of interest; the more so as I was prepared to barter with him for the whole of his materia medica, if my stock-in-trade would have sufficed.

It is amply clear from this statement, from Spruce's reports (Fig. 6) of other ethnobotanical observations and from the rich collections of artifacts which he collected and sent to the Economic Botany Museum of the Royal Botanic Gardens at Kew (Fig. 7) that he was not--as have been so many modern botanists working in South America's tropical regions–prejudiced against aboriginal uses of and beliefs about plants. He was certainly far from being a prejudiced man. An explanation of his failure to note the rich ethnopharmacological lore of this region may have several facets. Spruce may truly have been too busy and, much of the time, too ill to delve into this specialized field so tangential to floristic and taxonomic studies and collections.

FIG. 5.–Pods and beans of *Anadenanthera peregrina* collected on the Orinoco River in 1854 by Richard Spruce. Courtesy of the Royal Botanic Gardens, Kew.

FIG. 4.–Fruiting branch of *Anadenanthera peregrina.* Photograph: R. E. Schultes.

Even today, with modern transportation and other amenities not available a century ago, botanists engaged in floristic or taxonomic studies usually do not have the time available for ethnobotanical research. The great Amazon specialist, the late Dr. Adolpho Ducke, whose lifetime of collecting made him undoubtedly the modern master of the flora of this region, especially of the genus *Hevea*, wrote to me in a letter dated February 14, 1956, the indigenous use of *Hevea* seeds as food:

> I received your letter of Jan. 12 and the manuscript of your article on *Hevea* and Indians. I read the article which is certainly interesting, but unfortunately I am incompetent in matters of primitive Indians with whom I have never been in contact. All my collecting work was done in the civilized parts of the region.

And the late Dr. B.A. Krukoff, who carried out so many successful botanical expeditions to the Brazilian Amazon, once informed me personally that "an Indian is of no interest to me; I consider him an impediment to my work."

Spruce may, furthermore, perhaps have erred in assuming that all "medicinal" knowledge resided with the payé or medicine-man. I have consistently found that the payé, insofar as plants are concerned, often knows relatively little about plants in general, and usually manipulates "sacred" plants, usually the hallucinogens or other psychoactive species, such as coca and tobacco, and employes them "medicinally" in magical ways. Most tribes have what we might term "regular doctors", chiefs or "curacas", who do not normally use magic and who are well provided with a general knowledge of the curative

No. 1786. Acacia sp. (an Acacia Niopo?) (3)

This tree, known by the name of Paricá, is planted by the Indians near their houses, throughout the Solimoẽs, Madeira, Purús, Japurá, Rio Negro, Uaupés, Casiquiare, and perhaps upper Orinoco. The ~~nut~~ seeds are roasted and ground, in the manner of coffee, and the powder taken as snuff or in a clyster. Amongst the Mura, Purupurú and Catauixí Indians, who inhabit on the Rio Purús and about the mouth of the Madeira, the mode of using the Paricá is peculiar. The bone of a bird's leg is cut across, and the two pieces joined at such an angle that one end being placed in the mouth the other reaches the nostrils; a portion of Paricá is then put into the tube, and one end being applied to the mouth, the Paricá is blown from the other end with great force up the nose. The clyster-pipe is made on the same principle, of the long leg-bone of the Tuyuyú (Mycteria americana). The effect of Paricá taken as snuff, is to speedily induce a sort of intoxication resembling in its symptoms that produced by Amanita muscaria. Taken as a clyster it is a purge, more or less violent according to the quantity employed. When the Catauixí is about to set forth a-hunting he takes a small clyster of Paricá and administers another to his dog, the effects on both being (it is said) to clear their vision & render them more alert!

Throughout the Rio Uaupés, Paricá is almost the sole remedial agent employed, and it is not the ~~[illegible]~~ patient but the physician who takes it. When the Pajé (who is at the same time magician & physician) is about to treat a sick man, he first snuffs up his nose such a quantity of Paricá as suffices to throw him into a kind of ecstasy; he then lights a large cigar, from which he puffs the smoke over the hammock and other matters belonging to the sick person, and especially over the food he is to eat. The next operation ~~of the Pajé~~ is that of sucking the patient's body, on the seat of pain, whether the malady be internal or external, or as near to it as is practicable. I have never known any other mode of cure employed, except occasionally the milk of some tree (and they are not particular as to the species) ~~by way of~~ applied by way of plaster in the case of some internal pain. Hence the whole art of medicine on the Uaupés may be said, like that of Dr. Sangrado to resolve itself into two operations; but sucking & blowing are at least more innocent in their effects than bleeding and drinking warm water.

FIG. 6.–Spruce's field notes on the ethnobotany of yopo (*Anadenanthera peregrina*). Courtesy of the Royal Botanic Gardens, Kew.

FIG. 7.–Snuffing tubes of bird bones and mortar and pestle for grinding roasted seeds of *Anadenanthera peregrina* and for mixing lime to prepare yopo snuff. Guayabero Indians, Río Orinoco, Venezuela. Courtesy of the Botanical Museum of Harvard University.

or presumed therapeutic value of plants–that is those plants with actual physically active constituents able to relieve or cure ills of the body. They could justly be termed the "botanists" of the societies. They work cooperatively with the payés or medicine-men, very frequently referring difficult or recalcitrant cases to these "specialists" who are generally considered to be practitioners of a higher rank. It is, naturally, with these "regular doctors" and their knowledge that the ethnopharmacologist or ethnobotanist must primarily be involved.

Whether or not in Spruce's time–a century and a quarter ago–such practitioners did not exist we cannot now state with certainty. It is, however, most probable that they did exist and did practice their skill, although perhaps not with so much freedom from control of the payés as today. Spruce's surmise that the few household remedies practiced amongst these peoples may have come in with Europeans or negroes is open to serious doubt, if only from the fact that the plants and uses characteristic of the household medicine of the northwest Amazon are so utterly different from those of Europe and Africa. And a century ago there was very little European and no African influence in the northwest Amazon.

In June 1855, Spruce wrote the following list of ethnobotanical artifacts which he sent to Kew:

> 177. Apparatus for making and taking Niopo snuff, procured from Guahibo Indians at the Cataracts of Maypures. The *Niopo* of Venezuela is the same as the *Paricá* of Brazil and is used on the Upper Orinoco, Guaviare, Vichada, Meta, Sipapo, etc. There is no doubt of its being prepared from *Acacia Niopo* Humb., which is perhaps not different from *Piptadenia peregrina* Benth. My specimens of the Paricá tree from the Barra are referred to the latter species by Mr. Bentham. I did not see the tree from which the Guahibos obtained their Niopo and which they told me was planted in their conucos (garden plots) near the head waters of the river Juparo; but the Paricá I

have seen on the Amazon and all the way up the Rio Negro, planted near the villages, belongs to but one species which, on passing the Venezuelan frontier, takes the name of Niopo.

One startling fact stands out stridently from Spruce's notes (Fig. 7) made 130 years ago: that this tree is "planted by the Indians near their houses throughout the Solimões, Madeira Purûs, Japurá, Rio Negro, Uaupês, Casiquiare and perhaps upper Orinoco." Today, the plant is rare indeed in most of these localities. I have never seen it on the Solimões, nor on the Colombian sector of the Japurá (Caquetá in Colombia), nor on the Rio Negro nor Uaupês. Its extensive cultivation has apparently died out in most of these areas. G. Prance has found several trees of *Anadenanthera peregrina* cultivated on an affluent of the lower Rio Negro. Such a perspicacious botanist as Spruce, however, would hardly have confused this characteristic tree with any other; furthermore, he mentioned at great length the medicinal and narcotic use of the tree.

We are, consequently, left with the belief that—as with other cultivated plants, like guaraná *(Paullinia Cupana* HBK.)—the Rio Negro especially is far poorer in cultigens than it was more than a century ago.

Editor's note.—Assuming that others are as interested as I am in learning more about Richard Spruce, the pioneering ethnobotanist and explorer of northwest Amazonia, I suggest these selected references for further reading.

ANGEL, R. 1978. Richard Spruce, botanist and traveller, 1817-1893. Hortulus Aliquando 3:49-53.

SCHULTES, RICHARD E. 1951. Plantae Austro-Americanae VII. De festo seculari Ricardi Sprucei America Australi adventu commemoratio atque de princepaliter vallis amazonicis diversae observationes. Bot. Mus. Leafl., Harvard Univ. 15:29-78.

———. 1951. Richard Spruce still lives. Northern Gardener 7:2-27, 55-61, 87-93, 121-125. *Also,* pp. 13-49 *in* Hortulus Aliquando 3, 1978.

———. 1968. Some aspects of Spruce's explorations on modern phytochemical research. Rhodora 70:313-339.

———. 1968. The impact of Spruce's Amazon explorations on modern phytochemical research. Ciencia e Cultura 20:37-49.

———, B. HOLMSTEDT and J.-E. LINDGREN. 1969. De plantis toxicariis e Mundo Novo tropicale commentationes III. Phytochemical examination of Spruce's original collection of *Banisteriopsis Caapi.* Bot. Mus. Leafl., Harvard Univ. 22:121-132.

———. 1970. Notes of a botanist on the Amazon and Andes. Pp. v-x *in* Forward to reprinted edition of Spruce, R. (A.R. Wallace, ed.), Johnson Reprint Corp., New York.

———. 1976. Richard Spruce and the ethnobotany of the northwest Amazon. Rhodora 78:65-72.

———. 1978. Richard Spruce and the potential for European settlement of the Amazon—an unpublished letter. Bot. J. Linn. Soc. 77:131-139.

———. 1978. An unpublished letter by Richard Spruce on the theory of evolution. Biol. J. Linn. Soc. 10:159-161.

——— and A. HOFMANN. 1980. Pp. 167-168; Fig. 70 *in* The botany and chemistry of hallucinogens, Ed. 2. Charles C. Thomas Publ., Springfield, Illinois.

VON HAGEN, V. W. 1945. Richard Spruce, Yorkshireman. Pp. 230-270 *in* South America called them, Pt. IV, Chpt. XXIV. Alfred A. Knopf, New York.

J. Ethnobiol. 3(2):149-156 December 1983

LOVE POTIONS OF ANDROS ISLAND, BAHAMAS

SUSAN A. McCLURE
The Garden Center of Greater Cleveland
Cleveland, OH 44106

W. HARDY ESHBAUGH
Department of Botany, Miami University
Oxford, OH 45056

ABSTRACT.—The use of herbal love potions on Andros Island, Bahamas, is examined including the various species, plant parts used, methods of preparation and social and medicinal functions of the love potions. Twelve species are referred to including *Bourreria ovata, Bursera simaruba, Cassytha filiformis, Cordia bahamensis, Diospyros crassinervis, Erythroxylon rotundifolia, Eugenia axillaris, Phoradendron* sp., *Pinus caribaea, Swietenia Mahagoni, Tabebuia bahamensis* and *Thouinia discolor.* Information is based upon interviews with seven bush medicinal practitioners, each of whom employ a slight variation on the same basic recipe. In rural and urban sites, the use of bush medicine differs in that isolated rural areas must rely to a greater extent upon native cures while only remnant medicinal practices in the form of love potions remain in urban sites.

Although greatly disturbed, Andros Island still contains the elements of an essentially natural ecosystem. For several centuries the naturalized Africans in the West Indies have been sampling their environment and have compiled a substantial knowledge of those plants which are beneficial and harmful to man. The Caribbean island society has relied upon medicinal practitioners, in the past referred to as "grannies," who utilize the knowledge compiled by their ancestors to care for the daily medical needs of the community.

Today Andros Island is influenced to an increasing extent by the central Bahamian government as well as by contacts with travelers from other countries. Various developmental changes have brought about a gradual alteration of the traditional community life. One change accompanying development in the black communities (e.g. Great Abaco Island) is sexual infidelity, (Rodgers and Gardner 1969). Ultimately, this may explain the contradiction of the continued use of herbal love potions in urban areas while at the same time, medicinal herbal teas are being forgotten.

METHODS

Previous investigations of plants of economic importance in the Bahamas have been broad surveys resulting in lists of plants used by the native population, e.g. Anonymous (1971), Ayensu (1981), Eldridge (1975), Halberstein and Saunders (1978), Morton (1981). In this study the plants considered were only those commonly used in native love potions. Interviews were conducted with prominent medicinal practitioners on North Andros Island. The interview procedure followed that outlined by Wood (1975). All interviews, unless declined, were taped using a portable Superscope C-104 tape recorder and Scotch AVC 60 tape. The recorded tapes are deposited in the collections of the Willard Sherman Turrell Herbarium (MU).

The informants (native consultants) in this study included Mr. Doc Curry, Mr. Charlie Gilcot, Mrs. Amelia Marshall, Mr. James Thompson, Ms. Rosie Tusco, Mrs. Lona Williams and Mrs. Ena Woodside. Every effort was made to obtain complete information from the informants. When possible, in discussions with informants, plants were identified by fresh or dried samples of the species referred to rather than relying upon common names which were used inconsistently by several sources.

Bulk samples of dried plant material were obtained from at least two sites for each species including *Bourreria ovata, Cordia bahamensis, Bursera simaruba, Diospyros crassinervis* and *Thouinia discolor.* Two sites per species were required in order to collect an adequate sample since the species density at any one site was relatively low. The material was field dried for later analysis.

The various chemical analyses were carried out at the National Institute of Health, Purdue University, and Miami University. The National Institute of Health, Division of Cancer Treatment, National Cancer Institute, screened the material for antitumor potential. At Purdue University the material was screened for alkaloid content in the laboratory of Dr. Jerry McLaughlin by S. Pummingura. The studies at Miami University included a screening for tannins.

Two anticancer screens used by the National Cancer Institute are the 9-KB and the P-338 tests. The 9-KB assay is an *invitro* test on a culture of human nasopharynx cancer cells. The plant extract or purified compound is applied to the culture and the amount of growth inhibition measured as a function of protein concentration. If the pure compound inhibits tumor growth at less than 4 mg/ml it is considered active. If the extract inhibits growth at less than 20 mg/ml it is active. The P-338 assay is an *in vivo* test in mice. A 20 gram mouse is administered leukemic white blood cells. Control mice die within 10 days from administration. Plant extracts are injected daily for 9 days and any life extension in the mice measured. If the T/C (treated/control) life span value is greater than 130% the extract is considered active.

Alkaloid screening at Purdue University follows a standardized procedure. Dried, powdered plant material is extracted in $CHC1_3$-MeOH-NH_2OH (2:1:1) and with $CHCl_3$. The CHC13 filtrate condensed on a rotary evaporator with an aspirator vacuum. The resulting thick syrup is extracted with 3-5, 20 ml portions of 1N HC1. The acidic aqueous solution is extracted with 2, 100 ml portions of $CHC1_3$ and Et_20. At this point the acidic aqueous extract is set aside momentarily. The combined $CHC1_3$ and Et_20 fraction is dried over anhydrous Na_2SO_4 and condensed in the rotary vacuum until it reaches a syrupy stage. The residue is saved as fraction B.

The previously saved acidic aqueous solution is adjusted to pH 9.5 with 7.5 N NaOH and extracted with 2, 100 ml portions of $CHC1_3$ and Et_20. The basic NaOH extract is saved. The $CHC1_c$-Et_20 fraction is dried over anhydrous Na_2SO_4 and condensed under rotary vacuum to syrupy residue A, which should contain any alkaloids present.

The basic aqueous NaOH solution set aside in the last step is condensed on the rotary vacuum until all organic solvents are evaporated. The residue is freeze-dried and extracted with 3, 10 ml aliquots of 10% EtOH in $CHC1_3$. The insoluable salt is discarded and the organic solution condensed to syrupy residue C.

Residues A, B, and C are dissolved in small amounts of EtOH and separated by thin layer chromatography. Several solvent systems may be used on silica gel G, H, or PF_{254} plate. The solvent selected depends upon the compound present.

Identification of the alkaloid is made by comparison of the unknown with a standard sample, the use of spray reagents, and other analytical techniques. Spray reagents used include UV indicators, fluram, dansyl chloride, tetrazotized benzidine reagent, or I_2 vapor. Instrumentation such as GC, LC, IR, UV-Visible Spectrophotometers, NMR, MS, and X-ray crystallography are available at the Purdue University Pharmacology Department for identification and structural determination of unknown compounds.

The analysis for tannins uses one gram of dried leaves which are pulverized and extracted in boiling water. The lipophilic compounds are separated out into chloroform. An aliquot of the aqueous extract and a 5% tannic acid standard is tested with a ferric chloride test. This same aqueous extract is also tested for precipitation of a 50% gelatin solution. A second more sensitive method is used in which the pH is adjusted to 4 and .05 g NaC1 is added.

DISCUSSION

Information from different sources varies because of the background of the practitioner, the location of settlements, the differing extent of reliance upon the plants as medicines and the availability of each species in the bush.

Medicinal Practitioners.—Rural practitioners included Mrs. Amelia Marshall, Mrs. Ena Woodside and Mrs. Lona Williams. Mrs. Amelia Marshall (Fig. 1) of Red Bays is one of the leaders of the most remote village on north Andros Island which is isolated geographically and politically. She and many others in Red Bays are descendants of Africans and Seminole Indians who fled to this distant part of the island in the ninettenth century to escape persecution. Amelia Marshall is the great granddaughter of Sipian Bowleg, a Seminole medicine man from Low Sound, Bahamas. As a child she attended a few years

FIG. 1.—Mrs. Amelia Marshall, a prominent "granny" or "bush medicine" woman from Red Bays on North Andros Island, Bahamas (photo C. Rowand).

of school before becoming an apprentice to the village's practicing granny. Since then, she has ventured into the bush to taste different plants to evaluate their medicinal qualities. Her axiom is, "If it doesn't kill me, it won't kill you." She is training a male apprentice, Junior, who will take her place when she is too old to carry on. Mrs. Marshall has a very extensive knowledge of the local flora which she employs daily to treat the common ailments in the village. In the village of Standard Creek, Mrs. Ena Woodside is the matriarchal leader of a village of her descendants. Ella Woodside, Ena's daughter and apprentice for years, now has taken over part of the responsibility of brewing medicinal teas. Lona Williams, from Blanket Sound, and one of the authors (SAM) chanced to meet in the middle of a tidal flat where she was hunting crabs. When she saw that one of the authors was collecting plants of love potions (Fig. 2), she offered to divulge her recipe.

In contrast, the more urban settlements of Fresh Creek and Stafford Creek primarily have male practitioners. Mr. James Thompson, Mr. Charlie Gilcot, and Ms. Rosie Tusco in Fresh Creek and Mr. Doc Curry in Stafford Creek were interviewed. James Thompson is a grandson of an Andros Island medicine man. He remarked that, "During my Grandfather's lifetime, that's (drinking medicinal teas) why they lived so long. My Grandfather lived to be 84 years old." Although his experience was mainly limited to the love potions, he spoke of the Obeah superstitions on Andros and explained how certain plants are used in ceremonial rituals to curse an enemy. Most other sources refused to comment on this subject. Unlike James, Charlie Gilcot had an extensive medicinal background. However, since the establishment of the Andros Island Medical Clinic he seldom made any teas except for love potions. Originally born on Andros, Charlie moved to Mexico in 1936 where he worked on a ranch. Since there were no doctors, Charlie learned bush medicine from the Indians. After nine years, he returned to Andros. Like others in rural areas, Charlie was training an apprentice, Rosie Tusco. Rosie's interest began with her training in Haiti where she lived until 1973. She brews love potions regularly to facilitate her profession, prostitution. Doc Curry of Standard Creek claims his old age (75) and good health are the result of the teas he brews and drinks. At one time he had a regular clientele who purchased his remedies. Now his sales are limited to occasional strength or love potion sales.

Preparation.—All Bahamians interviewed use a combination of several herbs to brew a tea for energy which is necessary for maintaining sexual stamina, a highly desirable trait in this island society which is very concerned with procreation. Other terms used to describe the desirable action of these teas are: "to build you up," "to raise the blood," "to strengthen the back" and "for strength."

The recipe for the love potions varies according to the source, but the same basic plants are used (Table 1). Some additional plants were also mentioned, but since no specimens were available for identification they are not included in this paper.

The vine of *Cassytha filiformis,* the resinous inner bark of *Pinus caribaea* and the leafy twigs of the other species are boiled when used by all practitioners except Doc Curry. The resulting tea is bottled and stored in the refrigerator to be drunk anytime. Usually the tea is taken with sweetened condensed milk, although men are known to add rum also. Unlike the others, Doc Curry brews the roots. "Your strength lay in your leg, when your leg go then you go down . . . so not branch but root do the trick . . . " (Gilcot). At the time of the interview his wife was in the hospital in Nassau, so he remarked that he " . . . had to quit drinking the root tea for he woke at night." The solution to this problem was to change to drinking leafy twig teas or coffee. Since some of his American clients feel boiling the roots is unsanitary, Doc Curry steeps one half pint of roots in one gallon of lukewarm water to make his tea. He recommends curing the root tea by leaving it on the pantry shelf for one year before opening the jar.

The practitioners recommend drinking the tea anytime when feeling weak. When used as an aphrodisiac, the potion is drunk before bed. As Doc Curry says, " . . . if feel your staff is gone, you can drink anytime." Lona Williams promised to show Susan

FIG. 2.–Four of the main plants that serve as ingredients for love potions–A, *Bourreria ovata* (Strong Back); B, *Tabebuia bahamensis* (Five Finger); C, *Cassytha filiformis* (Love Vine); and D, *Diospyros crassinervis* (Stiff Cock) (photos W.H. Eshbaugh).

TABLE 1.–Some ingredients of Andros Island, Bahamas, love potions.

SCIENTIFIC NAME Names are arranged by family and follow the treatment of Correll and Correll (1982).	Plant part used	INFORMANT Marshall	Woodside	Williams	Tusco	Gilcot	Thompson	Curry	NOTES Chemical components/ other areas used in love potions
Bignoniaceae									
Tabebuia bahamensis (Northrop) Britt.	Leafy twig	X	X	X	X	X	X	X	Lapachol in genus/ Trinidad & Jamaica
Boraginaceae									
Bourreria ovata Miers	Leafy twig	X		X	X	X	X	X	
Cordia bahamensis Urb.	Leafy twig	X							
Burseraceae									
Bursera simaruba (L.) Sarg.	Leafy twig			X	X	X	X		Ethereal oils, tannins, sterols/ Bahamas
Ebenaceae									
Diospyros crassinervis (Krug. & Urb.) Standl.	Leafy twig	X	X	X	X	X	X	X	Long & Exuma Islands, Bahamas
Erythroxylaceae									
Erythroxylon rotundifolia Lunan	Leafy twig		X		X	X	X	X	
Lauraceae									
Cassytha filiformis L.	Vine	X			X	X	X		Alkaloids / Long & Exuma Islands, Bahamas
Loranthaceae									
Phoradendron sp.	Leafy twig				X				
Meliaceae									
Swietenia mahagoni (L.) Jacq.	Leafy twig				X	X	X		
Myrtaceae									
Eugenia axillaris (Sw.) Willd.	Leafy twig		X		X		X		Ethereal oils / Bahamas
Pinaceae									
Pinus caribaea Morelet	Inner Bark			X				X	Resin
Sapindaceae									
Thouinia discolor Griseb.	Leafy twig		X		X		X		

McClure her recipe for the love potion under the condition she would not drink the tea until she rejoined her husband. The potion is also drunk as a general tonic when feeling poorly and " . . . to keep the body in really super shape . . . " (Tusco).

Geographical Range of Use.–On other islands in the Bahamas and in the Caribbean, many of the same species are used in love potions. Ayensu (1981) notes that in Trinidad and Jamaica, *Tabebuia bahamensis* is boiled with several other species including *Diospyros crassinervis,* and *Swietenia mahagoni* as a "build up" tea for men. For strength, the root of *Tabebuia bahamensis, Bourreria ovata, Cassytha filiformis, Diospyros crassivervis, Bursera simaruba* and other species are boiled with a piece of iron. On Long and Exumas Islands, Bahamas, the leaves of *T. bahamensis, B. ovata, D. crassinervis, B. simaruba* and others are boiled with iron to enrich the blood and restore strength and energy (Eldridge 1975). Higgs (1969) notes *Eugenia axillaris* is used in the Bahamas as an aphrodisiac. Men in the Caicos Islands boil the roots of *E. axillaris* with several other species including *Tabebuia heterophylla* (Morton lumps *T. heterophylla* and *T. bahamensis* into a single species complex) to make an aphrodisiac tea (Morton 1981). In the Bahamas, shavings of *Swietenia mahagoni* bark are steeped in warm water and rum for 3 or 4 days and the infusion is taken as an aphrodisiac (Ayensu 1981). On Long and Exumas Islands, Bahamas, a leaf decoction is drunk to overcome weakness (probably sexual in nature) (Eldridge 1975).

Chemical and Pharmacological Aspects.—*Tabebuia bahamensis* (five finger) is used by all the practitioners interviewed in making love potions. Lapachol, isolated from the wood of some *Tabebuia* species, has been tested by the Natural Products Section, National Cancer Institute. Test results indicated inhibition of human nasopharynx carcinosarcoma (9KB) and mouse leukemia (P-338) (Lewis and Elvin-Lewis 1977). Gram positive acid fast bacteria and fungi are also inhibited by lapachol applications.

Bourreria ovata, known as strong back on Andros, tested negative in alkaloid screening at Purdue. Morton (1980) has speculated that the use of this plant for the blood may exemplify merely a symbolic cure since the decoction is blood red.

Only Mrs. Marshall used *Cordia bahamensis*, commonly called granny bush on Andros, in love potions. This reflects her former role as an unlicensed midwife. Granny bush is used primarily in teas or baths during and after birth. This practice has almost disappeared since the Progressive Liberal Party began to enforce a 1957 law requiring only registered midwives to attend births.

Bursera simaruba, known as gum elemi on Andros, is not only used frequently in love potions, but throughout the Caribbean and the Meso-American areas it is used medicinally for fever and colds, rheumatism and back pain, purgative and diarrhoea, dermatitis and tumors. Results of alkaloid screening were negative but tannins are present in aqueous solutions of leaf and twig. The National Institute of Health screened *B. simaruba* for anticancer activity. Of 27 extracts screened, nine were active (Suffness, personal comm.).

In *Bursera simaruba* several other biological actions have been recorded. The alcohol extract causes cytostatic activity in a microbiological system (Abraham et al. 1979). Fent and others (1962) screened a number of plants on specific isolated organ systems. Both the aqueous and the alcoholic extracts were tested. The aqueous fraction caused the death of two mice at a 0.5 ml dose. It was considered acutely toxic. An isolated rabbit heart was inhibited by 1 ml of aqueous solution. The alcoholic extract was not acutely toxic, but it increased the vascular flow of a rat hind limb and stimulated a rabbit duodenum. Both fractions inhibited contractions of a guinea pig ileum. These actions required relatively high doses of extract, thus the effect may be considered mild.

Diospyros crassinervis is commonly known as stiff cock on Andros which reflects the stiff, coriaceous nature of the leaves and its use in love potions as a male aphrodisiac. Alkaloid screening resulted in a negative reaction and little tannin activity was noted, yet the plant is commonly used by all practitioners.

Little pharmacological research has been focused on *Erythroxylon rotundifolia*, called bohog on Andros, but the alkaloid screening was negative.

Cassytha filiformis, known as love vine on Andros, is an orange parasitic vine that clings to many different shrubs. The common name, love vine, may reflect the clinging parasitic habit of the vine. *Cassytha filiformis* contains four tetrahydroisoquinoline alkaloids, laurotetainin, cassyfiline, cassythidine, and cassythicine (McLaughlin, personal comm.).

Little is known of the chemical properties of the native *Phoradendron* sp. and they are used only by Rosie Tusco in her love potions.

Swietenia mahagoni (mahagony) is used in love potions on Andros only in the settlement of Fresh Creek. The bark is rich in tannin and juglone (Morton 1981).

Eugenia axillaris, called iron wood on Andros, is one of the more infrequently used plants. No chemical or pharmacological research has been done on this species but fragrant ethereal oils are evident when fresh twigs are broken.

Thouinia discolor, known as hard bark on Andros, is also used alone for pain in the back, strength and fever. *Thouinia discolor* also gave a negative reaction to alkaloid screening.

Much more chemical testing must be done before any physiological basis for the use of love potions can be established. The information reported here serves only to document plant use in the Bahamas and suggest plants that might prove interesting if investigated further.

ACKNOWLEDGEMENTS

A portion of the research reported here was financially supported by grants from Sigma Xi, the Explorers Club and the Willard Sherman Turrell Herbarium Fund (No. 27). We would like to thank the staff and management of the Forfar Field Station, Andros Island, Bahamas, and especially Rose Blanchard and Dr. Thomas K. Wilson for all their assistance. Communications with Dr. Matthew Suffness, Head, Plant and Animal Products Section, National Cancer Institute, are acknowledged. Much credit must be given to Dr. Jerry McLaughlin and Suni Pummingura for the chemical analysis and instruction. S. A. McClure especially thanks her husband, Ted, for his support and understanding during the field work phase of the investigation.

LITERATURE CITED

ABRAHAM, A.M., N.R. HERNANDEZ, and C.A. MISAS. 1979. Extractos de plantas con propiedades citostaticas que crecen en Cuba, part 2. Rev. Cub. Med. Trop. 31:105-111.

ANONYMOUS. 1971. Bush medicine on San Salvador. Unpubl. San Salvador Pilot Program, College Center of the Finger Lakes, New York.

AYENSU, E.S. 1981. Medicinal Plants of the West Indies. Reference Publications, Inc., Algonac, Michigan.

CORRELL, D.S. and H.B. CORRELL. 1982. Flora of the Bahama Archipelago. J. Cramer, Vaduz.

ELDRIDGE, J. 1975. Bush medicine in the Exumas and Long Island, Bahamas; a field study. Econ. Botany 29:307-332.

FENG, P.C., L.J. HAYNES, D.E. MAGNUS, J.R. PLIMMER, and H.S. SHERRATT. 1962. Pharmacological screening of some West Indian medicinal plants. J. Pharm. Pharmacol. 14:556-561.

HALBERSTEIN, R.A. and A.B. SAUNDERS. 1978. Traditional medical practices and medical plant usage on a Bahamian island. Culture, Medicine, and Psychiatry 2:177-203.

HIGGS, L. 1969. Bush medicine in the Bahamas. Nassau, Bahamas.

LEWIS, W.H. and M.P.F. ELVIN-LEWIS. 1977. Medical Botany-Plants Affecting Man's Health. J. Wiley and Sons, New York.

MORTON, J. 1980. Caribbean and Latin American folk medicine and its influence in the United States. Q.F. Crude Drug Res. 18: 57-75.

———. 1981. Atlas of Medicinal Plants of Middle America. Charles C. Thomas, Springfield, Illinois.

RODGERS, W.B. and R.E. GARDNER. 1969. Linked changes in values and behavior in the Out Island Bahamas. Am. Anthropol. 71:21-35.

WOOD, P. 1975. You and Aunt Arie. Institutional Development and Economic Affairs Service, Inc., Washington, D.C.

J. Ethnobiol. 3(2):157-174 December 1983

PATTERNS OF VARIATION IN EXOTIC RACES OF MAIZE *(ZEA MAYS,* GRAMINEAE) IN A NEW GEOGRAPHIC AREA

RITA A. SHUSTER
Former Garden Manager, Dolores Archaeological Program, Dolores, CO 81323
and Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, CO 80309

ROBERT A. BYE, JR.
Former Co-principal Investigator for Environmental Studies, Dolores Archaeological Program, Dolores, CO 81323
and Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, CO 80309

ABSTRACT.—Over the past 3000 years exotic races of maize *(Zea mays* L.) were introduced, evaluated, sometimes discarded but often modified, and incorporated into North American agriculture. Present-day northern Mexico has served as a source area for many races. Whether maize was able to produce (i.e., yield acceptable products and viable propagules) in the new area or not after the first growing season was critical. A key factor in the success may have been the method of dispersal, for example gradual diffusion or long-distance jump-dispersal. This study examined the biological patterns of variability for the long distance jump-dispersal by using five contemporary Tarahumara races of maize from northern Mexico and a Papago race from southern Arizona as exotics and one contemporary Puebloan race, Hopi Blue maize, from southwestern United States as a native standard. Comparisons among morphological characters, developmental patterns, and productivity were made to develop the baseline for evaluating the biological and ecological factors for successful introduction and change of a component in the subsistence agricultural system. The maize was grown under a uniform environment in the experimental gardens of the Dolores Archaeological Program in southwestern Colorado.

INTRODUCTION

The movement of cultivated plants is as important as the origin of agriculture and the spread of agricultural techniques. The dispersal of cultivated plants provides information on the history of the plants as well as evidence of human contacts and trade (Carter 1945, 1979; Heiser 1965; Pickersgill 1972; Sauer 1969). Usually the evidence for dispersal of cultivated plants is derived from both modern and archaeological specimens which represent plants that were successfully introduced and established. These plants may have a particular geographic pattern and may be retained today or may be associated with past periods. The extant plants could also reflect long-term presence with modifications or could represent recent introductions. Plants may have been introduced in the past and their occurrence at different time periods would be recorded archaeologically (Ford 1979; Harlan and de Wet 1973). These patterns as well as variations in them tell us of the *products* of introduction of new plants but they reveal limited information about the *process* of introduction or exotics.

Recent reevaluation of archaeological plant remains in North America suggests that complexes of various crops moved along certain pathways at various time periods from present-day Mexico into present-day United States (Ford 1980). The developing picture suggests the movement of different plants at different times. One possible interpretation of this pattern is that only some plants were successful at any particular place at a given time period while other plants were not successful. What happened in the process of introduction? We only have the remnants of the final products left today.

Maize *(Zea mays* L.) has received considerable attention in the last forty years with respect to its origin and diffusion. Maize agriculture appears to have been introduced into the American Southwest by about 2000-1000 BC and slowly spread northward into Colorado and Utah by about 200 BC (Ford 1980; Woodbury and Zubrow 1979). The routes of the Upper and Lower Sonoran Complexes for the introduction of maize, beans and cucurbits followed the Mexican Sierra Madre Occidental and its western coastal plain (Ford 1980; Kelley 1966; Spence 1978). Subsequent introductions of maize succeeded and appeared to have had an impact upon the cultures in the area. Between AD 900-1100 in present-day northwestern Mexico, a rapid evolutionary spurt in maize occurred which transformed the maize being grown. This rapid change has been attributed to genetic recombination, heterosis and mutagenic effects of teosinte introgression (Mangelsdorf 1974) which suggests the introduction, acceptance, incorporation and selection of exotic races and their products. Similar patterns occurred in the present-day southwestern United States during the Pueblo II period (AD 900-1100). This introduction and modification of maize is thought to have been more productive and to have led to the expansion of agriculture in the arid Southwest. In fact, it is this increased biological diversity and subsequent productivity of the maize rather than a favorable climate which may have led to the expansion of agriculture and human populations in the region (Galinat and Gunnerson 1963; Mangelsdorf 1974). The establishment of exotic races as well as their hybridization with native races would provide the genetic basis for increased diversity which would amplify the patterns of variations of plant responses to the environment. These variations would be evaluated and selected upon by humans for desirable products and the favored races would be continued. The rise of the Fremont maize races in the American Southwest as well as the Cristilino de Chihuahua in northwestern Mexico and its counterparts in the Puebloan races suggests the importance of the dispersal of exotics into the Southwest and their effects on the local cultures. The specific evidence and patterns of movement and incorporation of exotic races into the Four Corners area based upon archaeological materials will not be presented in this paper because there is no uniform analysis of the maize materials at this time. However, establishing a framework for identifying the biological parameters of such movement and incorporation could contribute to a more meaningful interpretation of available archaeological specimens.

It is difficult to understand the process of dispersal[1] when we are presented with only static fragments of the past. In order to go beyond the descriptive phase and enter the explanatory phase of plant-human interactions, we must look at the patterns of responses of the plants in order to explain the results we observe. In examining the process we must look at the patterns of variation in the plants as responses to various environmental factors. Then this information can be combined with perceptions and values of the cultivated plants by certain cultures and with the characters which are influenced by human selection (for examples of maize, see Benz and Bye, in prep.; Clawson and Joy 1979; Johannessen 1982; Winkelmann 1976).

Maize may have been introduced as a package of various races associated with other cultivated plants and weeds. This complex may have moved slowly with a series of short steps (i.e., diffusion). Each step would have involved cultivation and subsequent selection and movement. On the other hand, a large distance between source area and the new home area may have been accomplished in a short period of time (i.e., jump-dispersal).

The environmental factors of the source area and the new home area may vary and consequently influence the expression of genetically fixed plant responses. Light, temperature and moisture are usually considered the dominant abiotic environmental factors which affect plant growth (Eastin et al. 1969; Milthorpe and Moorby 1974). Light is important as the source of energy which is fixed by the plant as well as the stimulus for developmental and growth patterns. Temperature affects rate of growth, length of growing season, and evapotranspiration rate. Uptake of moisture from the soil and moisture loss through evapotranspiration are critical to the metabolic pathways and nutrient transport. These factors often work together. The photoperiod (ratio of light to darkness) and the length of the growing season influence the initiation of flowering and subsequent fruiting. Temperature, in terms of absolute extremes as well as cumulative degree-days, affects the rates of growth and maturation. Moisture uptake and evapotranspiration rate strongly influence the growth and reproductive patterns of different races.

The responses of the plants of different races to the different environmental factors can be compared with one another. Those plants with desirable characteristics can be maintained by obtaining reproductive seeds for subsequent planting. Also hybridization of open pollinated plants, such as maize, can increase the genetic diversity within populations; the selection of progeny over generations could produce distinct local varieties. Plants with less desirable characteristics would not be as highly valued and consequently may not be continued. The differential reproductive potential, which is limited by biological and cultural factors, determines the success and duration of the maize races over time and the products that could be observed in the archaeological, historical and contemporary records. The critical points include: 1) increase of intraspecific genetic diversity and phenotypic variation, 2) preferential selection and subsequent planting of seeds from plant populations, and 3) comparison of several forms or races so as to select certain ones and discard others based upon the divergence of the characters in response to the new ambient environment.

THE SETTING

For the purpose of this study, the new home area was located in southwestern Colorado, ca. 10 km northwest of Dolores, Montezuma County. The source areas for the exotic maize package were the Sierra Madre Occidental of southwestern Chihuahua and the Basin and Range Physiographic Province of southern Arizona. A brief description of the environment at the Coloradoan home area and the Chihuahuan source area is presented below so as to compare the similarities and differences of the two extreme environments.

The new home area is located in the ecotone between the Ponderosa Pine Forest (with oak) and the Pinon-Juniper Woodland (with oak) at an elevation of ca. 2200 msm. The general area is situated at about latitude 37° 21′N where there are ca. 14¾ hours of light on the longest day during the growing season (Fig. 1).

The relationship between temperature and precipitation is critical. This can be expressed graphically in an ecological climate diagram (Walter 1979) using the relationship that 10° C equals 20 mm of precipitation based upon monthly means. This relationship between the temperature line and the precipitation line represents the intensity of moisture stress in the environment. Where the precipitation line is below the temperature line, aridity is assumed; the height of the difference represents the intensity of the drought and the width is related to the duration. Where the precipitation line is above the temperature line, humidity is assumed. This relationship when based upon several years of data should reflect the overall macroclimatic patterns although variation from year to year as well as over long periods of time is expected.

In the Dolores home area, the data for the general ecological climate diagram (Fig. 2a) is derived from the Cortez weather station. It is located ca. 23 km south of the study area is situated at ca. 1900 msm. It is the closest long-term weather recording station. Even though the specific data may be different from the Dolores home area, the general pattern should be similar. It should be noted, however, that the 1979 and 1980 weather patterns of the Cortez station were different from the normal pattern and that the limited data from the upper and lower garden sites of the Dolores home area were different from the Cortez records (Fig. 3a and b). The aridity usually occurs during the growing season which is calculated as the time between the dates of the 50% probability of the last spring freeze (0°C) and the first fall freeze. Soil moisture is regenerated by the winter precipitation. The normal growing season is about 131 days. During the 1979 season in Cortez, the aridity was more pronounced during the longer than normal growing season of 157 days but the precipitation during the non-growing season was greater (Fig. 3a). In the Dolores home area there was even less precipitation and an unusually short growing

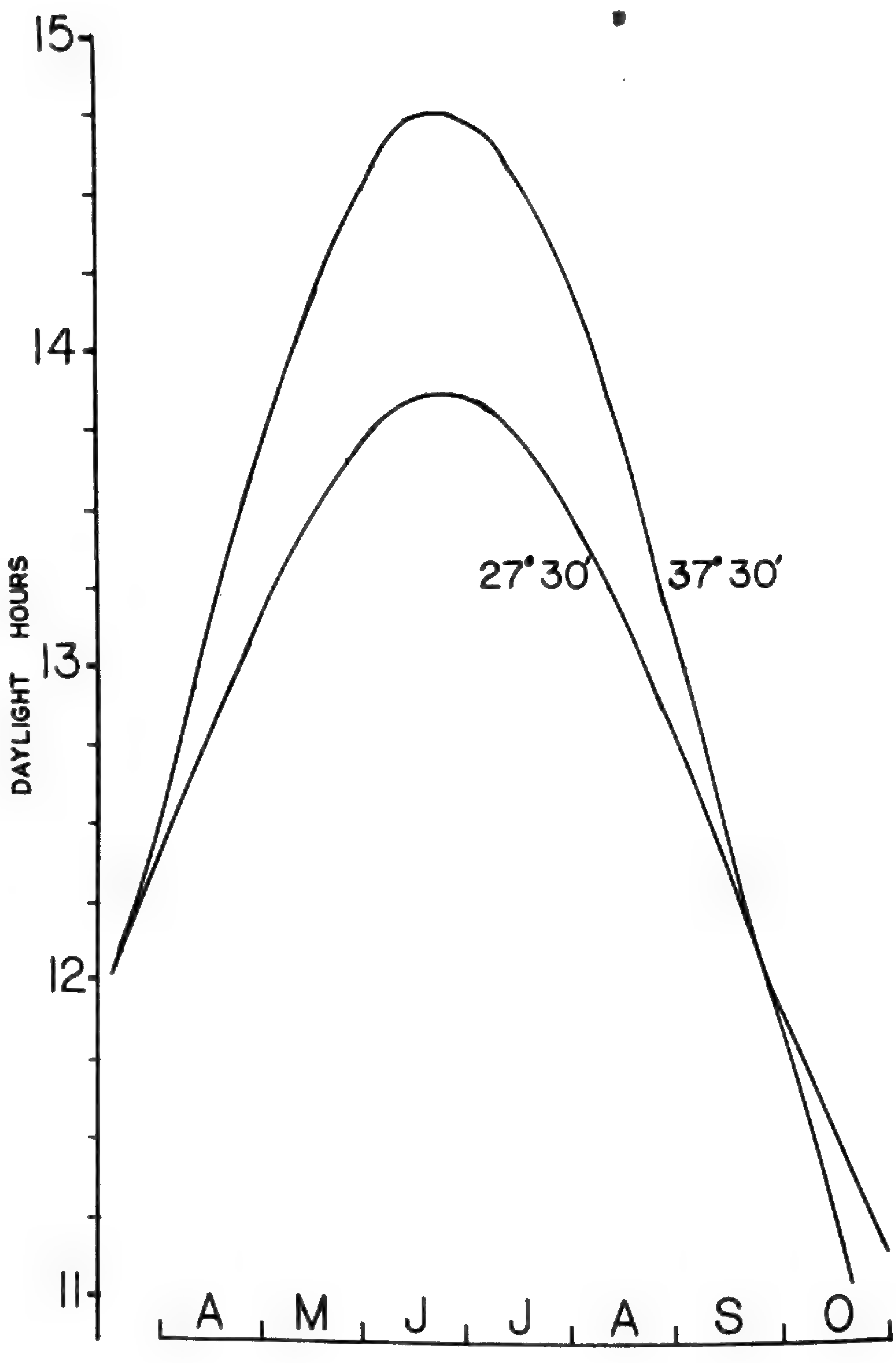


FIG. 1—Comparison of day length (as measured by daylight hours) for 27° 30'N in Chihuahua, Mexico, and for 37° 30'N in southwestern Colorado, United States, for April through October (based upon data extrapolated from Smithsonian Institution 1963).

season (87 days). During the 1980 season in Cortez, the aridity was even more pronounced than normal and worse than 1979 season (Fig. 3b). Even though the precipitation peaked during the winter months, the overall precipitation for 1980 was less than normal. In addition drought was extreme at the beginning of the growing season. The growing season at Cortez was a little longer than normal (137 days). In the Dolores home area, the precipitation was a little greater than at Cortez but the overall aridity was more pronounced than normal. The growing season was much shorter in both the lower garden (67 days) and the upper garden (98 days). In summary, the general growing season in the new home area can be characterized by a short arid growing season and by a non-growing season precipitation pattern.

The exotic package source area is located in the Pine-Oak Forest (with ponderosa

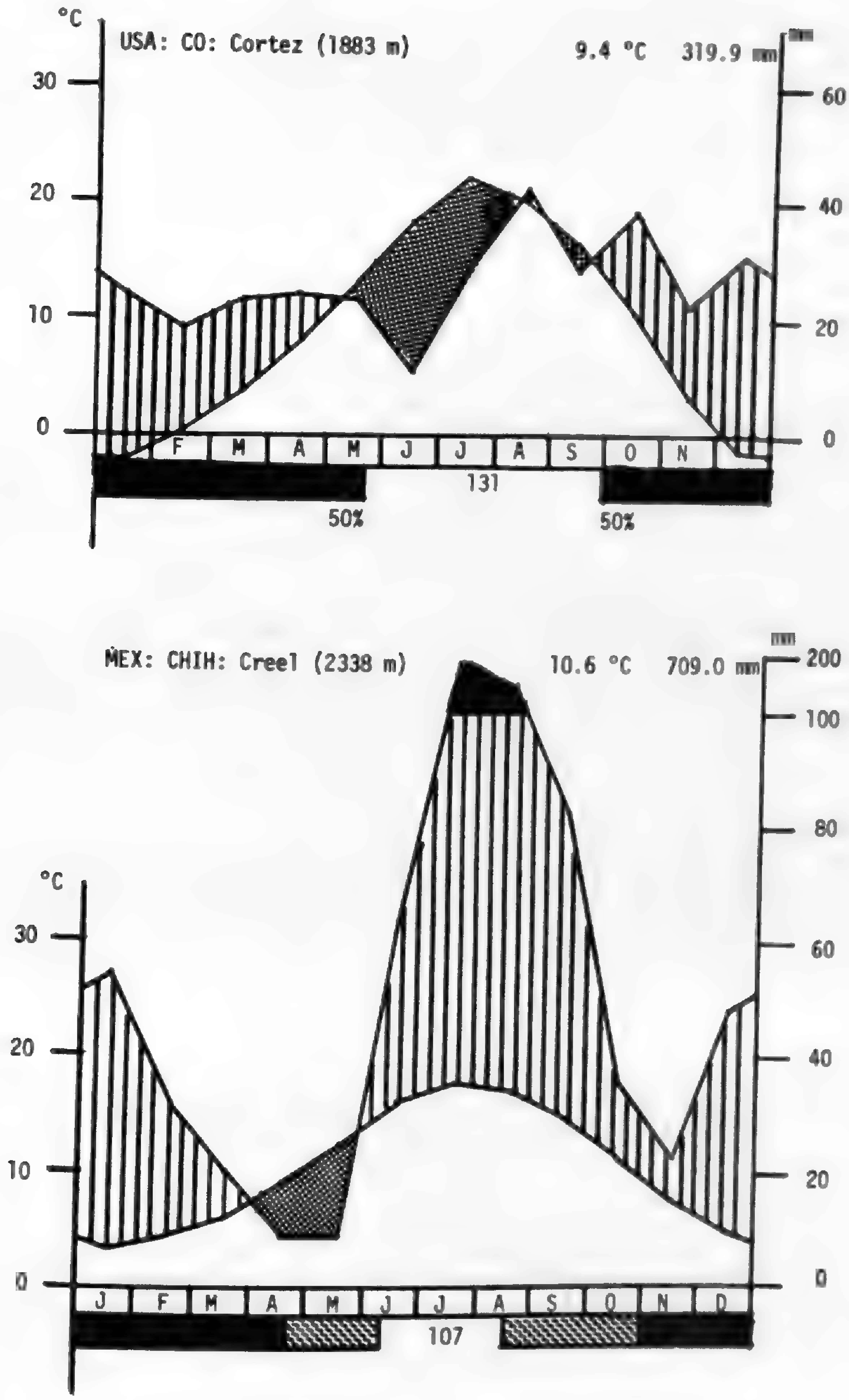


FIG. 2–Ecological Climate Diagrams (following procedures outlines by Walter 1979). 2a: Cortez, Montezuma County, Colorado, (based on weather data from 1951-1973) and 2b: Creel, Municipio de Bocoyna, Chihuahua, (based on weather data from 1953-1970).

pine) at an elevation of ca. 2200 msm. The general area is situated about latitude 27° 45′N where there are ca. 13¾ hours of light on the longest day during the growing season (Fig. 1). The relationship between temperature and precipitation is based upon the long term recording station located in Creel, municipio de Bocoyna (Fig. 2b). A short period of aridity occurs prior to the growing season in April and May. The heaviest precipitation falls during the growing season. The growing season is about 107 days.

The Coloradoan home area and the Chihuahuan home area are situated at similar altitudes and have comparable vegetation. Aridity is part of the climatic pattern of both areas but is more intense and of longer duration in Colorado. Also, the aridity period in Colorado occurs during the growing season while in Chihuahua it comes prior to the growing season. Chihuahua is wetter (709 mm per year) than in Colorado (320 mm per

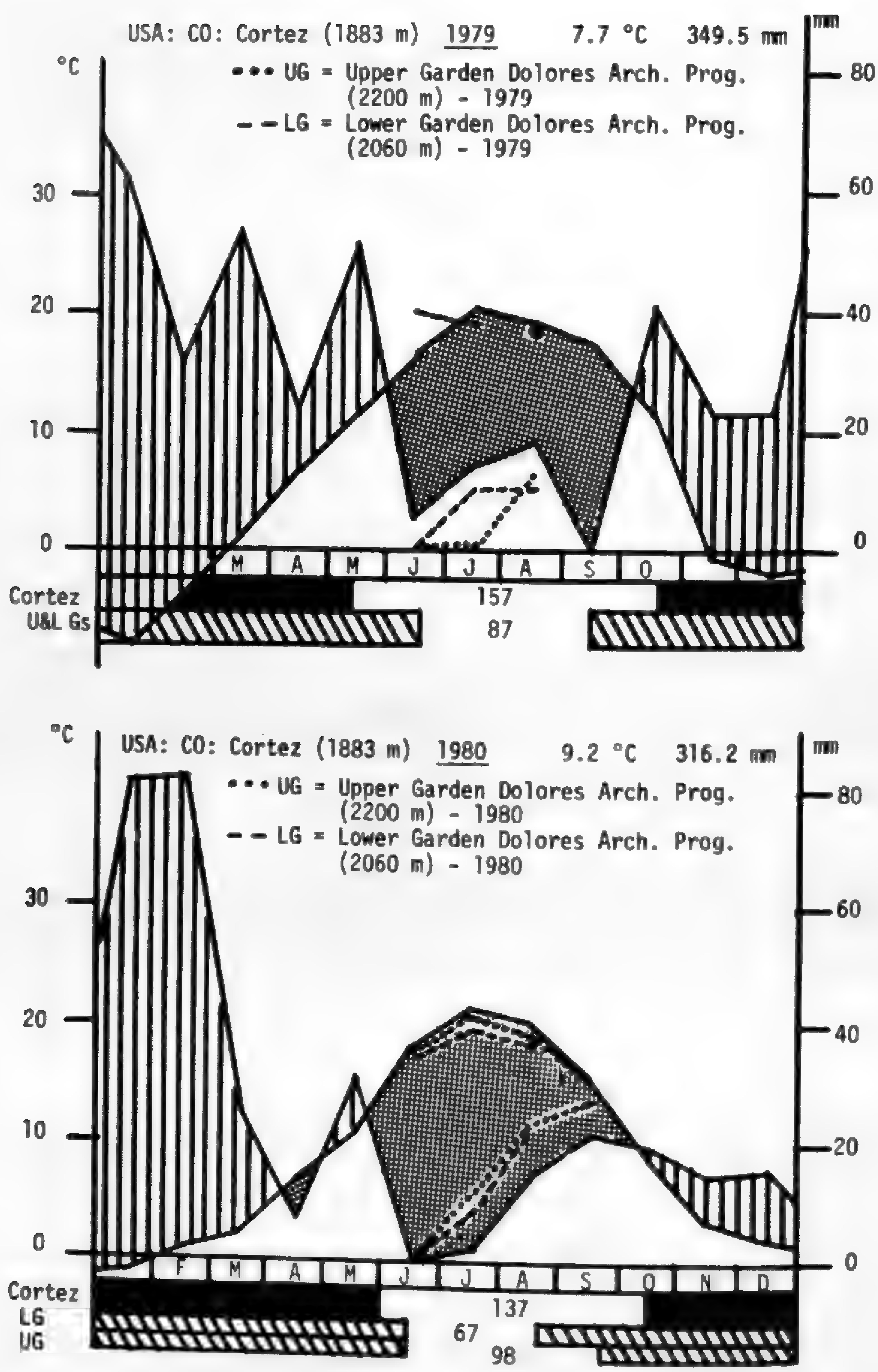


FIG. 3—Ecological Climate Diagrams for Cortez and for upper and lower gardens of Dolores Archaeological Program based on weather data from 1979 (3a) and 1980 (3b).

year) and the majority of the precipitation occurs as rain during the growing season in Chihuahua while the majority of the precipitation falls as snow during the winter or non-growing season in Colorado. The mean annual temperatures in the source area and in the new home area are similar (10.6°C and 9.4° C, respectively) but the growing season is longer in the general Coloradoan new home area (131 days) than in the general Chihuahuan source area (107 days). However, the growing season of the specific new home area in Dolores is shorter than the growing season of the general home area in Cortez and appears to be more similar to the Chihuahuan source area.

Overall the vegetation, elevation, and mean annual temperature are similar but the daylength, aridity, mean annual precipitation, and seasonal fluctuation of monthly mean temperatures are different. The length of average growing season seems to be different on a general scale but may be similar on the specific site. Although not discussed here, the soils are different in that the Coloradoan home area is dominated by Aridisols and Entisols derived from sedimentary bed rock while the Chihuahuan source area is dominated by Mollisols derived from volcanic bed rock.

Even though the Chihuahuan maize races, which are grown today by the Tarahumara subsistence agriculturists, would seem to require a more moist regime than that found in southwestern Colorado, a study was conducted to look at the responses of these exotic Mexican grown in the Four Corners region. These plants were grown in the new home area of southwestern Colorado as a consequence jump-dispersal. As discussed above, the Sierra Madre Occidental has served as a migration route, if not a source area, for the introduction of such cultivated plants as maize into the American Southwest. Although it is impossible to recreate the actual events of movement of maize from the Sierra Madre into the Four Corners area, it is possible to investigate some parts of the process associated with dispersal and to produce results which may be compared with archaeological and contemporary materials. The comparison of divergent responses of members from an exotic package (i.e., various races of maize representing intraspecific crop variation) with a native standard from the Colorado-New Mexican home area will allow some insights into the *process* of dispersal of maize into the Southwest from northwestern Mexico. Also, these insights will provide an analog and allow for a better understanding of the *products* which are left in the archaeological record.

MATERIALS AND METHODS

The races used in this study are those maize for which we could readily obtain kernels for planting. Each collection[3] represents (with one possible exception) one landrace[4] for each taxonomic race. For simplicity, we will refer to each collection as a distinct race. Hopi Blue flour maize, a variety of the Puebloan race (Brown et al. 1952; Carter and Anderson 1945), came from the 1979 crop grown in the Dolores garden. The original seed source from northern New Mexico was provided by Bob Gallegos. Because this race was adapted to the Four Corners region and had performed successfully in our first season, it was used as the native standard with which other races could be compared. Papago white flour maize, a variety of the Pima-Papago race (Carter and Anderson 1945), was obtained from Gary Nabhan in Tucson, Arizona. This race is considered similar to prehistoric Basketmaker maize (Anderson and Cutler 1942) and is noted for its rapid maturation and drought hardiness (Castetter and Bell 1942). Ears of Apachito[5], Azul[5], Cristalino de Chihuahua[5], Blando de Sonora[6], and Blanco[5,7] races (Hernández and Alanis 1970; Wellhausen et al. 1952) were collected from the Tarahumara Indians in the vicinity of Creel, Chihuahua. This group of one flour variety, Blando, and four flint varieties was considered in exotic package. From our discussions with Tarahumara farmers in October 1979, and October 1980, and our observations of maize plants in the fields at harvest time, these races appeared to be a unified package because of their similarities in growth responses, rate of maturation, morphology, and yield potential.

To compare the performance of the five Tarahumara varieties and the Papago maize with the standard Hopi Blue, kernels of all races were planted and raised under uniform conditions in the gardens of the Dolores Archaeological Program near Dolores, Colorado. Twenty hills of each race were planted on June 8, 1980. Hills were spaced at 1 m by 1 m with an additional 1 m boundary surrounding each plot. Three or four plants developed in each hill, and overall crop density averaged 1.75 plants per m^2. Seeds were inbibed before planting and 5 liters of water were applied to each hill at the time of planting and once again after seedlings had emerged. No further irrigation was supplied. Total rainfall between planting and harvest was 6.1 cm. Records were kept during the growing season on rate of growth and maturation of plants from each race. At maturity of the plants in mid-September, a series of morphological variables was measured on 20 plants from each race. Ears were harvested September 28-30, 1980, approximately 112 days after planting.

RESULTS AND DISCUSSIONS

Crop productivity of different races was determined by growth and development patterns, morphological characters of mature plants, and yield of ears. Patterns of divergence or similarity between the exotic races and the native standard indicate factors that affect the ability of introduced races to mature in a new geographic region, demonstrate ecological and morphological differences between plants of different races, provide comparison of yield potential between introduced and native races, and show divergence among races within the exotic package when it is introduced into a new region. The data are derived from the populations in the upper garden rather than the lower garden which experienced a short growing season.

Growth rates and development.—Differences in the growth rates and development as measured at time of maturation of the maize races grown at Dolores appear to be responses to temperature and photoperiodic sensitivity. For all races, increase in plant height and number of leaves prior to tasselling was directly related to accumulated heat units. The duration of vegetative growth between planting and flowering is dependent on temperature, and one effect of cool nights is to prolong this period of growth (Brouwer et al. 1973; Shaw 1976). Mean daily temperatures of 15-18° C, as recorded in Dolores from June to September (Fig. 4), can retard maize maturation (Jenkins 1941). This should not have affected the Tara humara races since the temperatures during the growing season in Chihuahua are similar to those recorded for Dolores. However, the effect was strongly pronounced in the Papago maize. This type of maize is reported to produce ears in 60-65 days near Tucson (Gary Nabhan in Meals for Millions 1981), but required 100 days in Dolores. Monthly mean temperatures for a similar period in Tucson range from 26-30° C. Because maize growth is so temperature dependent, the number of days between planting and maturation varies greatly with site location and climate and is not a constant for any race (Wallace and Bressman 1949).

Photoperiod also affects the time of flowering in sensitive races of maize (Francis 1973; Mangelsdorf 1974). Plants of maize often grow taller and have more leaves when grown at higher latitudes because of delayed floral initiation; vegetative growth goes on longer through the growing season before the tassel and silks develop. Mature plants of the four Tarahumara flint races (Apachito, Azul, Blanco, and Cristalino) had from 14 to 18 leaves per stalk at maturity and ranged from 130 to 225 cm tall in the Dolores garden. In the Tarahumara region, plants matured on approximately the same schedule as those in Dolores, and also had 14 to 18 leaves at maturity and ranged from 125 to 250 ml tall. In this case, the differences in vegetative growth and rate of maturation due to a latitudinal shift of 10° did not exceed the range of phenotypic variation shown by plants in both settings. Plants of the flour race, Blando, however, did show a response to a latitudinal shift. In Chihuahua, Blando plants were similar in height and rate of maturation to those of the other four races, but in Dolores the Blando plants were taller than those of the other four races and ears had only developed to the milk stage by early October.

Hernández and Alanis (1970) report that Azul maize flowers in 65 days after planting and Apachito maize flowers in 55 days; both tasselled at 60 days in Dolores and produced silks in 72 days. The delay between tasselling and silking in Dolores was a symptom of drought stress on the plants (Aldrich and Leng 1965). This delayed silking is the basis for reports that corn matures more slowly under drought conditions (Hack 1942). Sensitivity to drought was most extreme in the Tarahumara race Azul, which wilted severely at midday, and least noticeable in the Papago flour maize, which kept normal leaf color and position. This sensitivity may be related to the number of tillers per plant in either race. The total leaf surface area of Azul was greatly increased by the 3-4 tillers per stalk which developed. Very few plants of Papago maize produced tillers. The standard Hopi Blue maize was intermediate in both number of tillers and tolerance of

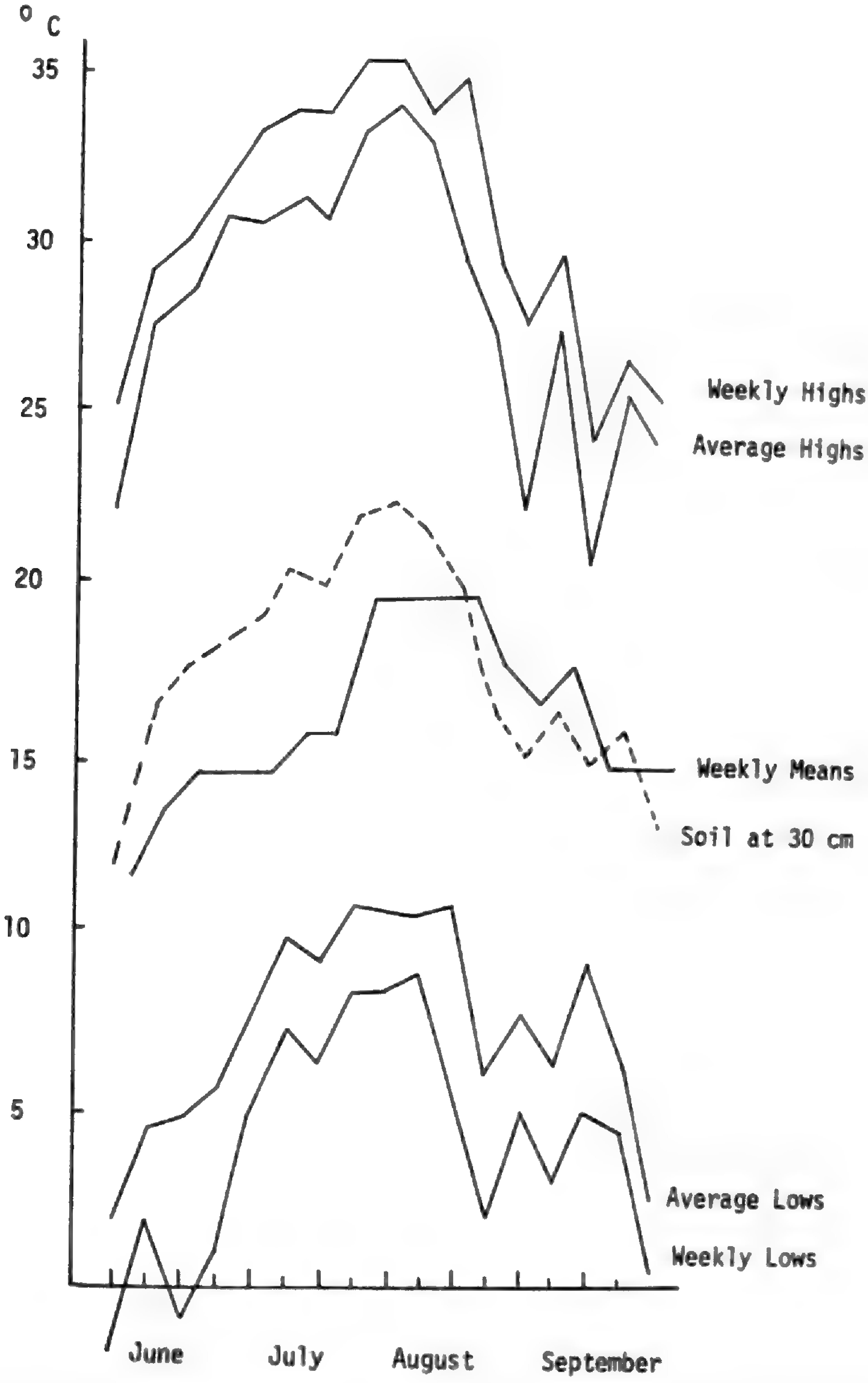


FIG. 4–Air (solid lines) and soil (dashed line) temperatures recorded at the upper garden of the Dolorres Archaeological Program and reported as weekly means, weekly extreme means (average highs and lows), and absolute extremes (weekly highs and lows) for the 1980 season.

drought. Because the average summer rainfall in Chihuahua is so much greater than that in Dolores (Fig. 2), it was expected that all plants of Tarahumara maize would be affected by drought stress more than plants of either Hopi Blue or Papago maize. This hypothesis was supported by observations of leaf response on hot afternoons in late July and August. However, the Tarahumara plants produced normal mature ears and showed neither poor kernel set nor incomplete filling at the tips of the ears, characteristic manifestations of drought stress.

Morphological characters of mature maize plants.–Races of maize are traditionally distinguished on the basis of ear and kernel characteristics (Anderson and Cutler 1942; Brown and Goodman 1977). Since vegetative characters are more plastic than reproductive characters, they are less useful in discriminating between races (Goodman and Paterniani 1969). However, as races evolve in restricted geographic areas, they are selected for adaptation to local climatic conditions (Bird 1970) in addition to biotic and cultural factors. This process has resulted in a divergence of developmental and vegetative characters as well as ear and kernel characters. When introduced into a new area, differences in these characters will influence the potential productivity and successful reproduction of the exotic race.

One aspect of the architecture of mature maize plants is the location of the main ear on the stalk. Ears were borne as low as the ninth and tenth nodes in Hopi Blue and Papago maize, as high as the fourteenth in Blando, and in between at the eleventh and twelfth nodes in the four Tarahumara flint races. In addition to this variation in ear location relative to the nodes, the average ear height ranged from only 50 cm in Hopi Blue to 102 cm in Blando. Ear placement may be related to yield potential. Mangelsdorf (1965) reports that leaves above the ears supply photosynthates to the developing kernels, and that leaves below the ear supply the root systems. He predicted that if plants from races which bear ears low on the stalk have more leaves above the ear, they should show increased yield but decreased root system development compared with plants from other races with higher ears. These predictions were not substantiated by the plants at Dolores. Hopi Blue and Papago maize plants had both the lowest ears and the most leaves above the ear but did not have identical increased yields. Both showed good drought resistence compared to the Tarahumara races.

Morphological characters, which were measured on a sample of 20 plants from each race, were chosen to represent the dimensions, proportions, vegetative vigor, and potential yield of ears. Some characters were based on previous studies of maize (Goodman and Paterniani 1969; Wellhausen et al. 1952), and others were added for this study (Table 1). Although one-way analysis of variance showed that significant differences among the seven races from each other. Some characters showed much more variation than others. For example, plant height to the tassel base ranged from 134 ± 4 cm in Papago to 194 ± 4 cm in Blando, but both had tassels 38-40 cm tall.

TABLE 1.–*Morphological measurements of maize plants, based on previous studies of characters important in racial determination (Goodman and Paterniani 1969; Welhausen et al. 1952) with some characters added or modified for the purposes of this study.*

1. Height of plants to tops of leaves.
2. Height of plants to node of the base of the tassel.
3. Length of tassel along primary axis from base to top.
4. Height of stalk from ground to node at which top ear develops.
5. Number of leaves, including the first four which develop from the embryonic plumule.
6. Number of leaves above the top ear and below the tassel.
7. Length along the midrib of the leaf subtending the top ear.
8. Width of that leaf, measured midway down its length.
9. Number of tillers produced by the main stalk.
10. Number of primary branches on the tassel.
11. Number of mature ears per plant.
12. Number of secondary ears per plant that arise on the tillers or on the main stalk below the primary ear, and do not develop to maturity but can be consumed as "green" corn.
13. Number of axillary ears arising between the husks of the primary ear on a stalk. These are tiny but can be consumed entire.

To test the strength of the relationship between different characters and test hypothesis of correlation, the Pearson's r coefficient was determined for several pairwise combinations of variables. The results support the hypotheses that (1) height to leaftops, height to tassel base, and height to top ear are strongly related, (2) total number of leaves, number of leaves above the top ear, and measures of height are strongly related, (3) leaf length and leaf width are strongly related, and (4) number of tillers is independent of the other variables.

A multivariate approach was needed to utilize the information on morphological characters while recognizing the correlation between them. The purpose of the analysis was to emphasize the significance of the morphological differences between races, which imply differences in potential productivity and successful introduction of races. Discriminant function analysis was performed on the data set to create linear combination of variables which maximize the differences between the races. Using the functions created in this analysis, 120 of 143 cases (84%) could be properly assigned to one of the seven races. Thus, this analysis confirms that racial differences can be distinguished on the basis of vegetative plant morphology as well as ear and kernel morphology. A plot (Fig. 5) of the results from this analysis clearly separates the Tarahumara races from the Southwestern races, and further separates the races within the two main groups, so that Hopi Blue and Papago are distinct and the Tarahumara races also spaced out slightly. Because of the great morphological plasticity of maize plants, the functions used in this classification would not necessarily apply to plants grown in other gardens. Approaches to racial classification based on more conservative characters are more universally applicable. However, for the purpose of indicating differences among plants of various races that could affect the successful growth, maturation, reproduction, and acceptance of exotic maize in a new region, this type of analysis in helpful.

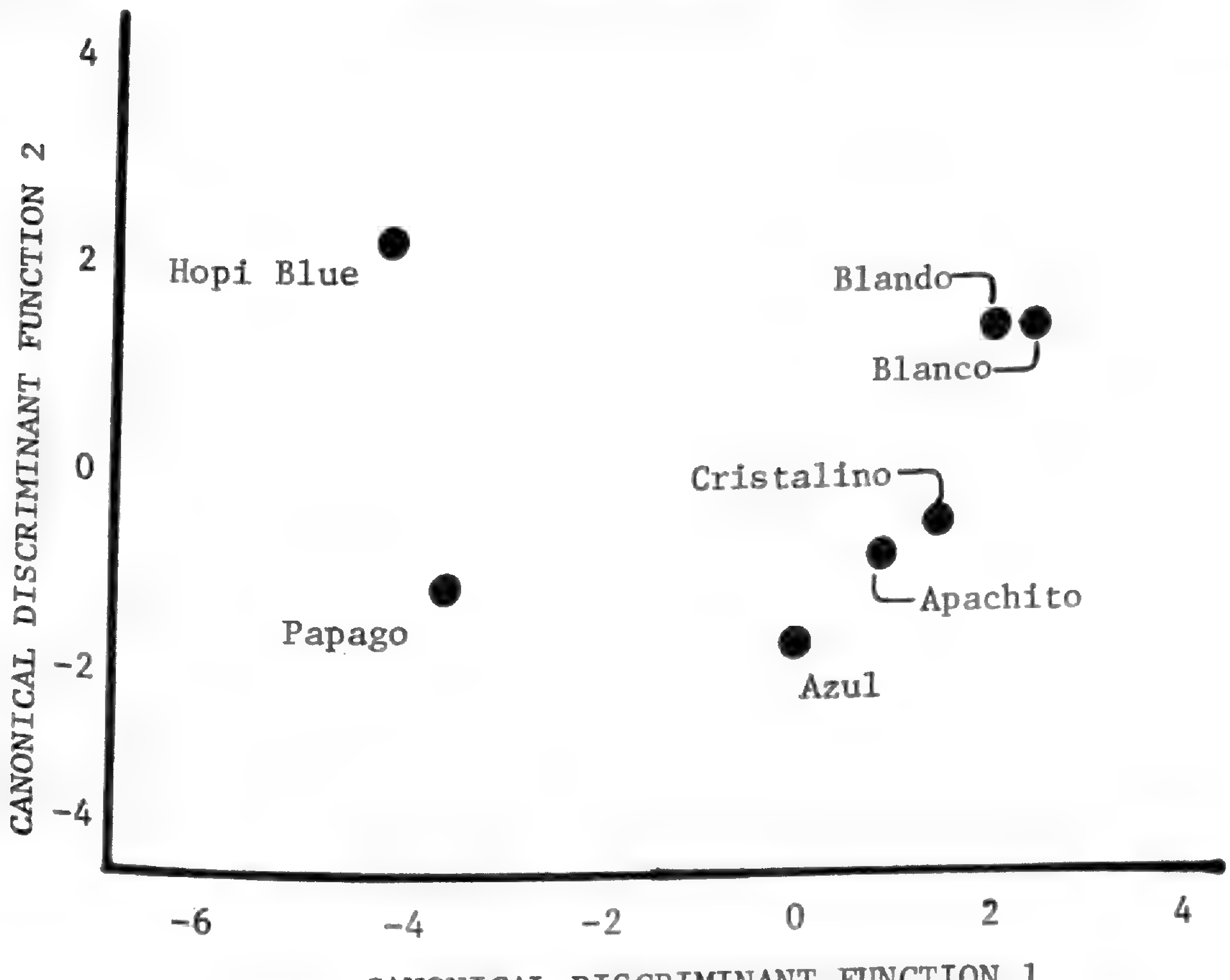


FIG. 5—Plot of group centroids based upon vegetative morphology of maize grown in Dolores, Colorado. Group centroids for each of the seven races of maize are presented for the first two discriminant functions.

Yield of ears in different races of maize.—Ears of Papago maize and the four Tarahumara flint races reached the milk stage by September 12-15, one week in advance of Hopi Blue and 2-3 weeks in advance of Blando. Maize ears may be harvested and consumed at this stage, but usually kernels are not fully mature until 3-4 weeks later and ears increase greatly in weight and carbohydrate content during this period. Differences in degree of maturity of the ears at the time of harvest at the end of the growing season have important consequences. The fate of races introduced into the Southwest from regions further to the south depends on the ability of the plants to produce seeds in the new setting. After harvest in late September and subsequent drying, ears were sorted into categories of immature and nature for measuring the weighing. Immature ears were those that had been picked with kernels in the milk stage. Their kernels shrank during drying and were small, wrinkled, and light colored. Fully mature ears had large, well-filled, bright-colored kernels. Intermediate ears were common. Since later germination tests showed that the seeds from intermediate ears were viable even though they were not fully filled kernels, these intermediate ears had reached reproductive maturity and were grouped with the fully mature ears. Fully mature ears are culturally important as a major food staple, but reproductively mature ears are also important as a possible means of renewing the plant population and establishing a race in a new region.

The four Tarahumara flint races (Apachito, Azul, Blanco, and Cristalino) produced mature ears that were very similar in length and weight (Table 2). Average ear weight in Blando was much less because these ears were not fully mature but only reproductively mature. Ears of Papago flour were slightly shorter and lighter than in the four Tarahumara flint races. Ears of Hopi Blue were significantly longer and heavier at maturity than ears of the other races.

In Blanco, Cristalino, Hopi Blue, and Papago maize the immature ears were those produced at lower nodes of the main stalk or on the tillers. They were shorter than the top ears and of course weighed much less. This trend was even more pronounced in Apachito and Azul which produced very short immature ears. In Blando, however, many of the top ears on the stalks were immature. These were as long as or longer than the mature ears produced on other stalks of that race.

Immature ears can be consumed fresh but are less desirable as a food source after drying. The pericarp and glumes are more fully developed than the endosperm in these immature ears and constitute a larger proportion of the dried kernels. In mature ears, 75% of the weight is in the kernels and most of this is in the endosperm.

Total yield of immature and mature ears from twenty hills of each race is presented in Table 3. Again it appears that the four Tarahumara flint races (Apachito, Azul, Blanco and Cristalino) produce similar numbers and weights of both immature and mature ears. Blando produced as many total ears, but fewer reached maturity so the total weight produced was very low. Hopi Blue produced numbers and weights of mature and immature ears intermediate between the four flint races and Blando. Papago flour maize produced the most mature ears and the greatest weight of both mature and total ears. This variation among races is summarized in Figure 6, which shows number and dry weight of mature ears produced per plot of each race.

Among subsistence agriculturalists, maize ears are carefully selected at harvest time as seed sources for the coming year (Beaglehole 1937; Whiting 1939). Some traditional farmers are very conservative about maintaining their own seed stock. Others take interest in unusual or exotic races and grow trial plots to compare with their traditional forms (Johnson 1972). The introduction of maize from Mexico into the Southwest depended on many factors including the importation of seeds, the growth and maturation of the plants, and the cultural acceptance of the new crop. As Sauer (1967:139) summarized:

> The diffusion of corn . . . undoubtedly required a long time. The older forms of maize may be considered as having required a long, warm, moist season, more rapidly maturing forms developing by slow selection on the successive boreal fringes of its cultivation and in part also

on the drier margins. Slow ecologic selection was demanded of all crops that diffused through a wide latitudinal and altitudinal range, the diffusive energy of such a crop being probably a complex expression of its desirability and of inherent ecologic plasticity.

TABLE 2.—*Length and weight of mature and immature ears of seven races of maize. n = 140.*

Race	— Mature Ears —		
	No. of ears	Length (cm)	Weight (gm)
Apachito	26	17.1 ± 0.68	58.3 ± 5.06
Azul	23	16.2 ± 0.55	58.5 ± 4.40
Blanco	21	17.9 ± 0.52	55.8 ± 5.01
Cristalino	28	17.4 ± 0.93	63.0 ± 5.97
Blando	4	18.4 ± 2.14	28.0 ± 2.09
Papago Flour	27	17.4 ± 0.39	52.0 ± 2.42
Hopi Blue	8	19.6 ± 1.22	71.7 ± 11.50
	— Immature Ears —		
	No. of ears	Length (cm)	Weight (gm)
Apachito	10	10.3 ± 0.77	8.3 ± 2.00
Azul	15	8.4 ± 0.57	6.9 ± 0.78
Blanco	14	11.9 ± 0.88	14.0 ± 2.86
Cristalino	18	11.8 ± 0.86	13.8 ± 2.73
Blando	27	21.5 ± 2.12	14.7 ± 2.83
Papago Flour	11	13.4 ± 1.05	17.3 ± 3.40
Hopi Blue	42	13.4 ± 0.64	20.7 ± 3.19

TABLE 3.–*Total yield of mature and immature ears of seven races of maize. Ears were harvested September 26, 1980 from twenty hills of each race, grown at 1m x 1m spacing in 3m x 4m plots in Dolores, Colorado.*

RACE	–Mature Ears –		– Immature Ears –		–Total Ears –	
	Total No.	Wt. (gm)	Total No.	Wt. (gm)	Total No.	Wt. (gm)
Apachito	67	3630	47	540	114	4170
Azul	60	3240	60	640	120	3880
Blanco	62	3400	48	670	110	4070
Cristalino	53	3250	35	550	88	3800
Blando	14	600	95	1400	109	2000
Papago Flour	89	4550	44	740	133	5290
Hopi Blue	40	1700	67	1400	107	3100

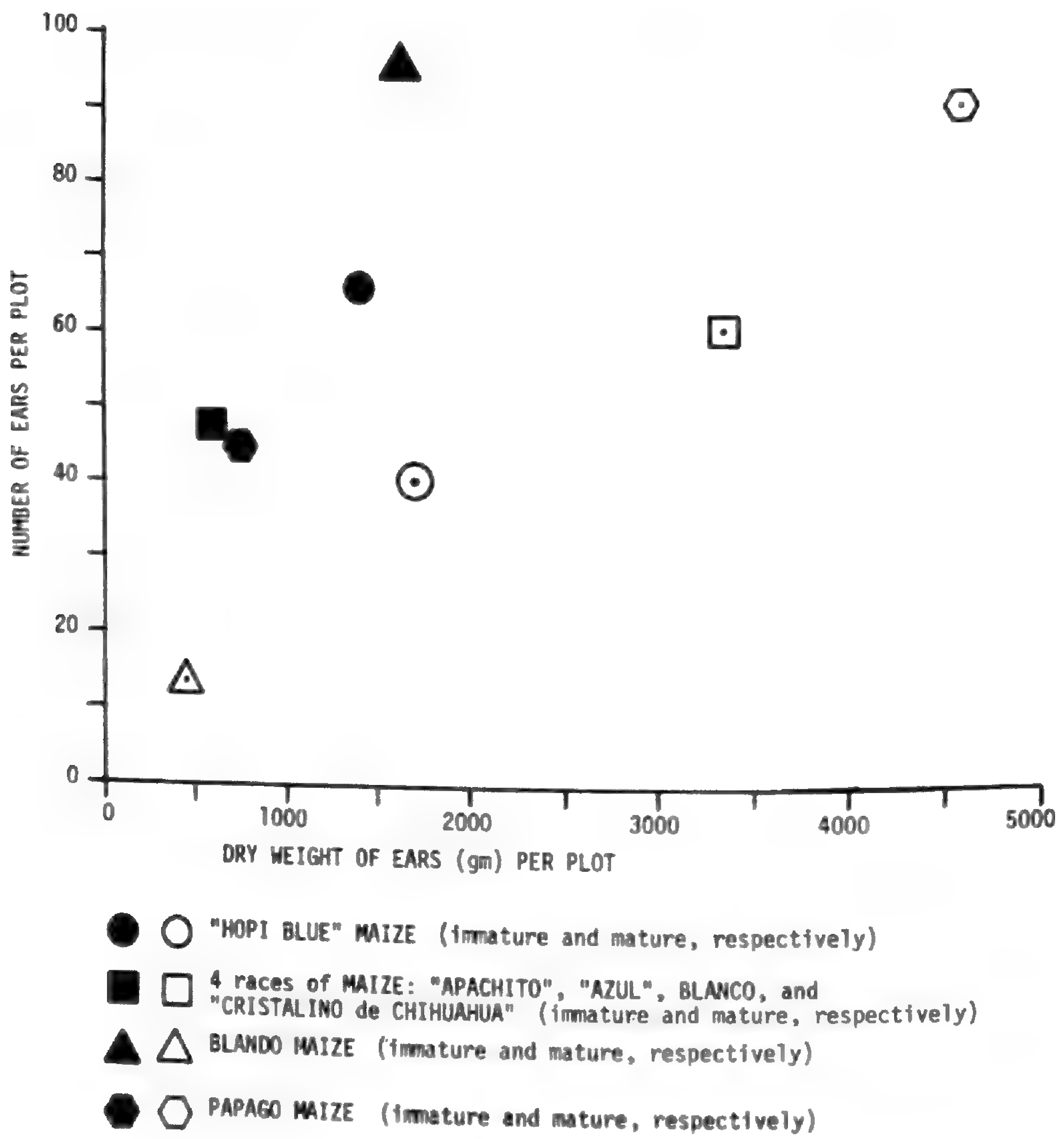


FIG. 6–Immature and mature ear yields per plot (area = 25 m^2; density = 1.75 plants per m^2) at upper garden of Dolores Archaeological Program during 1980 season. Note: the square approximates the yield of one of four Tarahumara flint races; these four races had similar yields.

SUMMARY

1. Maize can be introduced into a new region by means of jump-dispersal where the kernels from a source area are carried a great distance in a short time and established in a new region. In this study, five Tarahumara races of maize from southwestern Chihuahua, Mexico, and one Pima-Papago race from southern Arizona were grown in gardens in southwestern Colorado and compared with a native standard Hopi Blue of the Puebloan race. This jump represents a shift of ca. 10° latitude or ca. 1260 km for the Tarahumara races and a shift of ca. 5° latitude or ca. 630 km for the Papago race. The source areas and new home area differ in photoperiod, temperature and precipitation patterns. Plants of all races produced mature ears in the first year.

2. Blando was the only Tarahumara race of maize that showed prolonged delay in floral initiation in the new home area. This can be attributed to photoperiodic effect. Papago maize required 50% more days to mature in southwestern Colorado than in southern Arizona possibly because of retarded growth at lower temperatures. Extreme aridity during the growing season produced symptoms of drought stress of the foliage in the Tarahumara races, but ear production and quality did not seem to be strongly affected. The Papago and Hopi maize plants did not show drought stress symptoms. In all races, ears reached at least the state of reproductive maturity.

3. Although the five Chihuahuan races were considered similar in terms of growth responses, rate of maturation, morphology, and yield potential in their native setting, a divergence was observed among these races when they were grown in southwestern Colorado. The four flint races, Apachito, Azul, Blanco, and Cristilino de Chihuahua, matured earlier and produced more mature ears than the native standard, Hopi Blue flour variety. The flour race, Blando de Sonora, did not reach full maturity but yielded some ears which were reproductively mature. Plants of these five exotic races also showed divergence in vegetative morphology. Papago flour maize matured earlier and produced more mature ears than any other race in the Dolores garden, including the native standard, Hopi Blue flour maize.

LITERATURE CITED

ALDRICH, S.R., and E.R. LENG. 1965. Modern Corn Production. The Farm Quarterly, Cincinnati, Ohio.

ANDERSON, E., and H. CUTLER. 1942. Races of maize: I. Their recognition and classification. Ann. Missouri Bot. Gard. 29:69-89.

BAKER, H.G. 1971. Commentary: Section III. Pp. 428-444 *in* Man Across the Sea. Problems of Pre-Columbian Contacts (C.L. Riley, J.C. Kelley, C.W. Pennington, and R.L. Rands, eds.). Univ. Texas Press, Austin.

BEAGLEHOLE, E. 1937. Notes on Hopi economic life. Yale Univ. Publ. 15:33-48.

BENZ, B., and R. BYE. in prep. Racial classification in maize *(Zea mays* L.): an example using Tarahumara maize.

BIRD, R. McK. 1970. Maize and its cultural and natural environment in the Sierra Huanuco, Peru. Unpubl. Ph.D. Dissert. (Biology). Univ. California, Berkeley.

BROUWER, R., A. KLEINENDORST, and J. TH. LOCHER. 1973. Growth responses of maize plants to temperature. Pp. 169-174 *in* Plant Responses to Climatic Factors (R.O. Slatyer, ed.). UNESCO, Paris.

BROWN, W.L., E.G. ANDERSON, and R. TUCHAWENA, JR. 1952. Observations on three varieities of Hopi maize. Amer. J. Botany 39:597-609.

BROWN, W.L., and M.M. GOODMAN. 1977. Races of maize. Pp. 49-88 *in* Corn and Corn Improvement (G.F. Sprague, ed.). American Society of Agronomy, Madison, Wisconsin.

CARTER, G.F. 1945. Plant Geography and Culture History in the American Southwest. Viking Fund Publ. Anthr. No. 5. The Viking Fund, Inc., New York.

CARTER, G.F. 1974. Domesticates as artifacts. Pp. 201-230 *in* The Human Mirror. Material and Spatial Images of Man. (M. Richardson, ed.). Louisiana State Univ. Press, Baton Rouge.

CARTER, G.F., and E. ANDERSON. 1945. A preliminary survey of maize in the Southwestern United States. Ann. Missouri Bot. Gard. 32:297-318.

CASTETTER, E.F., and W.H. BELL. 1942.

LITERATURE CITED (continued)

Pima and Papago Indian Agriculture. Univ. New Mexico Press, Albuquerque.

CLAWSON, D.L., and D.R. HOY. 1979. Nealtican, Mexico: A peasant community that rejected the 'Green Revolution'. Amer. J. of Econ. and Soc. 38(4)371-387.

EASTIN, J.D., F.A. HASKINS, C.Y. SULLIVAN, and C.H.M. VAN BAVEL (eds.). 1969. Physiological Aspects of Crop Yield. American Society of Agronomy, Madison, Wisconsin.

FORD, R.I. 1979. Paleoethnobotany in American archaeology. Advances in Archaeological Method and Theory 2:285-336.

FORD, R.I. 1980. 'Artifacts' that grew their roots in Mexico. Early Man 2(3):19-23.

FRANCIS, C.A. 1973. The effects of photoperiod on growth and morphogenesis in maize *(Zea mays* L.): field trails in Columbia. Pp. 57-60 *in* Plant Responses in Climatic Factors (R.O. Slatyer, ed.). UNESCO, Paris.

GALINAT, W.C., and J.H. GUNNERSON. 1963. Spread of eight-row maize from the prehistoric Southwest. Bot. Mus. Leafl. (Harvard Univ.) 20:117-160.

GOODMAN, M.M., and E. PATERNIANI. 1969. The races of maize: III. Choices of appropriate characters for racial classification. Econ. Botany 23:265-273.

HACK, J.T. 1942. The changing physical environment of the Hopi Indians of Arizona. Papers of the Peabody Museum of Harvard Univ. No. 35.

HARLAN, J.R. 1975. Crops and Man. American Society of Agronomy, Madison, Wisconsin.

HARLAN, J.R., and J.M.J. DE WET. 1973. On the quality of evidence of origin and dispersal of cultivated plants. Curr. Anthrop. 14(1-2):51-62.

HEISER, C.B., Jr. 1965. Cultivated plants and cultural diffusion in nuclear America. Amer. Anthrop. 67:930-949.

HERNÁNDEZ X., E. and G. ALANIS FLORES. 1970. Estudio morfológico de cinco nuevas razas de maiz de la Sierra Madre Occidental de México: implicaciones filogenéticas y fitogeográficas. Agrociencia 5(1):3-30.

JENKINS, M.T. 1941. Influence of climate and weather on growth of corn. In United States Department of Agriculture Climate and Man, 1941 Yearbook of Agriculture. Government Printing Office, Washington, DC.

JOHANNESSEN, C.L. 1982. Domestication process of maize continues in Guatemala. Econ. Botany 36(1):84-99.

JOHNSON, A.W. 1972. Individuality and experimentation in traditional agriculture. Human Ecol. 1:149-159.

KELLEY, J.C. 1966. Mesoamerica and the southwestern United States. Pp. 95-110 *in* Handbook of Middle American Indians, Univ. Texas Press, Austin, Vol. 4.

MANGELSDORF, P.C. 1965. The evolution of maize. Pp. 23-49 *in* Essays of Crop Plant Evolution (J.R. Hutchinson, ed.). Cambridge Univ. Press, London.

MANGELSDORF, P.C. 1974. Corn. Its Origin, Evolution, and Improvement. Harvard Univ. Press, Cambridge.

Meals for Millions/Freedom from Hunger Foundation. 1981. Southwest Traditional Crop Conservancy Garden and Seed Bank. Tucson, Arizona.

MILTHORPE, F.L., and J. MOORBY. 1974. An Introduction to Crop Physiology, Cambridge Univ. Press, London.

PICKERSGILL, B. 1972. Cultivated plants as evidence for cultural contacts. Amer. Antiq. 37(1):97-104.

PIELOU, E.C. 1979. Biogeography. John Wiley & Sons, Inc., New York.

SAUER, C.O. 1967. American agricultural origins: a consideration of nature and culture. Pp. 121-144 *in* Land and Life, (J. Leighly, ed.). Univ. California Press, Berkeley.

SAUER, C.O. 1969. Agricultural Origins and Dispersals. The Domestication of Animals and Foodstuffs. Massachusetts Institute of Technology Press, Cambridge.

SHAW, R.H. 1976. Climatic requirement. Pp. 591-623 Corn and Corn Improvement, (G.F. Sprague, ed.). American Society of Agronomy, Madison, Wisconsin.

SMITHSONIAN INSTITUTION. 1963. Smithsonian Meteorological Tables. United States Government Printing Office, Washington, DC.

SPENCE, M.W. 1978. A cultural sequence from the Sierra Madre of Durango, Mexico with an Appendix: Corn from seven Durango, Mexico, caves by H.C. Cutler. Pp. 165-189 *in* Across the Chichimec Sea (C.L. Riley and B.C. Hedrick, eds.). Papers in Honor of J. Charles Kelley, Southern Illinois Univ. Press, Carbondale.

WALTER, H. 1979. Vegetation of the Earth and Ecological Systems of the Geo-biosphere. Springer-Verlag, New York.

WALLACE, H.A., and E.N. BRESSMAN. 1949. Corn and Corn Growing. John Wiley and Sons, Inc., New York.

WELLHAUSEN, E.J., L.M. ROBERTS, E.

LITERATURE CITED (continued)

HERNÁNDEZ X., and P.C. MANGELSDORF. 1952. Races of Maize in Mexico. Bussey Institute of Harvard Univ., Cambridge.

WHITING, A.F. 1939. Ethnobotany of the Hopi. Museum of Northern Arizona, Flagstaff.

WINKELMANN, D. 1976. The Adoption of New Maize Technology in Plan Puebla, Mexico. Centro Internacional de Merjoramiento de Maiz y Trigo, Mexico, DF.

WOODBURY, R.B., and E.B.W. ZUBROW. 1979. Agricultural Beginnings, 2000 B.C.-A.D. 500. Pp. 43-60 *in* Handbook of North American Indians: Southwest, (Vol. 9). (A. Ortiz, ed.). Smithsonian Institution, Washington, DC.

NOTES

1. Dispersal is a general term which is broadly applied to the concept movement of organisms from one area to another. It has been used in many ways and is the source of some confusion. Also, certain plants are considered to be adapted for short distance dispersal with gradual expansion of their ranges, others for long range distance dispersal, and others for both strategies. A useful framework for understanding dispersal is presented by Pielou (1979:242-243). Three modes of the spread of a species are: 1) *jump-dispersal* which describes the movement of individual organisms across great distances in a short period of time with successful establishment of the population and its descendants, 2) *diffusion* which is the gradual movement of populations across hospitable environments over a longer period of time, and 3) *secular migration* where diffusion is greatly reduced such that the species undergoes appreciable evolutionary change. Baker (1971) has provided a series of criteria for testing the dispersal of a plant with or without human aid with reference to gradual range expansion (diffusion) and long-distance dispersal (jump-dispersal). The biological as well as the cultural characteristics of dispersal as a process are still in need of critical investigation.

2. In the case of maize, the seed or kernel is a one-seeded fruit which is technically known as caryopsis.

3. Specimens of the maize have been made for deposition in the Anasazi Cultural Heritage Center. Related collections are deposited in the Laboratory of Ethnobotany and Plant Systematics, Department of EPO Biology, University of Colorado, Boulder.

4. Landrace can be defined as a subset of a race which is highly variable in appearance and genetic diversity but which retains particular properties and characteristics (Harlan 1975).

5. These four races were obtained in October 1977 from a Tarahumara ranchito in Cusárare, ejido de Cusárare, municipio de Guachochic, at an elevation of ca. 2100 msm.

6. This race was obtained in October 1977 from a Tarahumara ranchito in the ejido de San Ignacio Arareco, municipio de Bocoyna, at an elevation of ca. 2200 msm.

7. This undescribed race is a white flint with morphological similarities to Apachito.

ACKNOWLEDGEMENTS

We wish to acknowledge the many people who provided the material, financial and facility support and the encouragement for carrying out this project. The garden studies were part of the Environmental Manipulation Program of the Environmental Studies Group (ESG) of the Dolores Archaeological Program (a cultural mitigation project funded by the Water and Power Resource Services with the University of Colorado as the contractor, Dr. David A. Breternitz, Senior Principal Investigator). Several members of the ESG along with Rob Milhoan offered advice and field assistance. Gary Nabhan, William J. Litzinger, and Bruce Benz provided advice, material and much needed encouragement through the study seasons. Bob Gallegos of "Bueno" Food Products, El Encanto, Inc., Albuquerque, NM, donated the original bulk quantity of Hopi Blue Flour maize for the 1979 season. The Tarahumara Indians of Chihuahua, Mexico, are acknowledged for sharing their seeds, knowledge and enthusiasm of food plants with us. Field trips to the Tarahumara region were conducted under the direction of the second author (R. Bye) and were sponsored by the Department of Environmental, Population and Organismic Biology, by the Graduate School, and by the Museum of the University of Colorado, Boulder. We appreciate the critical and constructive comments on earlier versions of this manuscript by Vorsila Bohrer, Charles Miksicek, Gary Nabhan, and anonymous reviewers.

POSTSCRIPT

Subsequent studies in the experimental garden as well as in the laboratory were planned to examine more carefully the biological and ecological factors affecting maize along with other cultivated plants and associated weeds as well as to integrate those results with cultural information and archaeological materials from the Dolores area and other regional archaeological sites.

Unfortunately, the objectives of the Dolores Archaeological Program changed resulting in the elimination of support for the Environmental Studies Group. Consequently, our experimental, field, laboratory, and literature studies were discontinued. None the less, two Master of Arts theses (R. Shuster, 1981. Factors affecting productivity in subsistence agriculture. Dept. of EPO Biology, University of Colorado. and B. Benz, 1981. Five modern races of maize from northwestern Mexico: archaeological implications. Dept. of Anthropology, University of Colorado.) and an introduction to a model integrating contemporary and archaeological data (R. Bye and R. Shuster, in press. Developing an integrated model for contemporary and archaeological agricultural subsistence systems. In P. and S. Fish (eds.). Prehistoric Agriculture Strategies in the Southwest. Arizona State University Anthropological Research Paper.) were completed. With the writing of these items and the resignation of R. Bye, the Environmental Studies Program came to an end before the relationship between the general theme of this paper and the archaeological and ethnobotanical evidence could be properly integrated.

NEWS AND COMMENTS

CALL FOR PAPERS: SEVENTH ANNUAL ETHNOBIOLOGY CONFERENCE

April 15-17, 1984, University of Washington, Seattle, WA

PAPERS

Papers will be limited to 20 minutes. To schedule a paper please submit an abstract of 150 words, a title, a list of author(s) with address(es), and the name of the person to present the paper. Please indicate required audiovisual services. ABSTRACTS MUST BE RECEIVED BY FEBRUARY 1ST. They should be sent to Dr. Eugene Hunn, Department of Anthropology, University of Washington, Seattle, WA 98195.

SCHEDULE

April 15 / evening	Reception and registration
April 16 / morning	Registration, presentation of papers
afternoon	Presentation of papers
evening	Banquet of Northwest Indian foods Special presentation by Margaret Siwallace Nuxalk Indian elder "On Making Ooligan Grease"
April 17 / morning	Presentation of papers
afternoon	Presentation of papers

NOTE: Symposia are being planned on Indigenous Foods and Chinese Herbal and Nutritional Medicine. Abstracts of papers on indigenous foods, particularly their nutritional values, should be forwarded by December 1st to Dr. Harriet Kuhnlein, Division of Human Nutrition, The University of British Columbia, Vancouver, B.C., Canada V6T 1W5. Abstracts of papers on Chinese herbal and nutritional medicine should be forwarded by February 1st to Dr. Eugene Anderson, Department of Anthropology, University of California, Riverside, CA 92521.

MELVILLE AND ELIZABETH JACOBS RESEARCH FUND
Whatcom Museum Foundation

The Melville and Elizabeth Jacobs Research Fund invites applications for small individual grants to support research on Native American cultures primarily of northwestern North America. The Fund is designed to facilitate field research rather than analysis of previously collected materials. Appropriate are field studies of any aspect of culture and society, with emphasis on expressive, conceptual, and purely linguistic systems. (Projects in archaeology, physical anthropology, urban anthropology, and applied anthropology or applied linguistics will not be funded.) Awards range from $200 to approximately $800; salary cannot be supplied, and only minimum living expenses can be considered.

For further information and application forms, contact the Melville and Elizabeth Jacobs Research Fund, Whatcom Museum of History & Art, 121 Prospect St., Bellingham, Washington 98225. *Application deadline is February 15, 1984*

The Society of Economic Botany will hold its 25th Annual Meeting at Texas A&M University, June 11-13, 1984. The symposium "Ethnobotany of the Greater Southwest" will focus on past, present, and future interactions between plants and man in the southwestern United States and northern Mexico. Symposium presentations and discussions will involve specialists from both the United States and Mexico. Registration materials and information can be obtained from Hugh D. Wilson, Biology, Texas A&M University, College Station, Texas 77843. Those wishing to contribute papers should contact Dr. Gregory Anderson, Biological Sciences Group, University of Connecticut, Storrs, Connecticut 06268.

John Ciardi's etymological essay aired on National Public Radio June 6th, 1983, in Seattle took a turn our way. He noted the fact that a new productive English suffix has evolved in recent years, "-athon," as in "walkathon," "talkathon," "bikeathon," even "birdathon," and, of course, the original "marathon." The suffix can be seen to mean roughly "an exhaustive, prolonged contest." He noted also that marathon, a foot race of 26 miles and some odd yards, took its name from the Plains of Marathon in Greece, scene of the climactic battle between Athens and Persia, news of which was carried to the victorius Athenians by an heroic runner who collapsed and died at his goal. Ironically, the plains of that name are socalled after the wild fennel (presumably *Foeniculum vulgare* Miller) which must have flourished beneath the warriors feet, then decorated their graves.

The *Arizona Daily Star* (Tucson, Arizona, 18 May 1983) under Ed Severson's byline reports a unique local educational event, the Flowing Wells High School ethnobiology class final exam, a banquet prepared by students and faculty featuring traditional foodstuffs of the Papago Indians and other Southwestern native peoples. Featured were "cottontail tacos, agave hearts, boiled tumbleweed, venison seca, cactus 'Jello-O', rattlesnake meat" and a variety of foods derived from beans of the mesquite tree, "the Papago Indians' tree of life." It is encouraging to see *ethnobiology*—defined in this article as "how the plants and animals of their [Southwest Indians] environment were used in their culture—introduced to high school students. Soon it will be a household word. Thanks to W. Van Asdall.

A visionary application of ethnobiology is being pioneered by the Institute of Ecotechnics, a U.S.-spawned, London-based (24 Old Gloucester St., London, W.C.1) organization devoted to establishing a new discipline, Ecotechnics, to deal "with the relations of men with their biosphere." A major resource of the Institute is their 82-foot research vessel *R/V Heraclitus,* a floating ethnobiological laboratory. The ship embarked this past February upon a 2½ year "Around the World Ethnobotanical Expedition," sequel to their 1979 "Flora Tropica Expedition" up the Amazon River. Ecotechnic literature reflects a blend of hard-nosed science and global consciousness.

Ethnobotanical research is a priority of the Academia Sinica of the People's Republic of China through its support of the Yunnan Institute of Tropical Botany (P.O. Box 302, Xishuangbanna Menglun, Mengla, Yunnan). The institute—founded in 1959—boasts a research garden of 1000 hectares with 2500 species of tropical plants from China and abroad. The garden is surrounded by a nature sanctuary in virgin tropical forest. Research emphases include tropical plant taxonomy, tropical forest ecosystems, cultivation of economic plants, and phytochemistry. The Institute has recently (1982) edited and published a volume of *Collected Research Papers on the Tropical Botany,* in Chinese with some English abstracts. The volume is dedicated to the eminent Chinese botanist and late Institute director, Tsai Hsi-tao (1910-1981). The collection includes reports of an ethnobotanical survey of self-sufficient aboriginal ethnic groups of Xishuangbanna district, a study of timber utilization by these indigenous minorities, an evaluation of the value of introducing Cuban balsa trees for local cultivation, as well as various horticultural experiments. Thanks to Peter Nute, Anthropology, University of Washington.

William Tucker's Crosscurrents column in *Science 83* (March, 1983:92-94) discussed new evidence supporting J.V. Neel's "thrifty genotype" theory of diabetes. Neel proposed *(American Journal of Human Genetics* 14:353-362, 1962) that this affliction of 11 million Americans might be the consequence of recent dietary changes, in particular, the constant availability of ample quantities of sugar and starch in modern diets. Neel surmised that a diabetes gene may have provided its bearers with a survival advantage under conditions of limited and irregular food supplies, since diabetes in effect rations sugar metabolism. Under conditions of abundance this "rationing" overloads the blood with sugar. The recent "epidemic" of diabetes among many Native American populations (K. M. West, *Diabetes* 23:10, 1974) appears to support this hypothesis. Tucker summarizes a study by D. L. Coleman (*Nutrition Reviews*, May 1978) of mice fed starvation diets. Such mice with two diabetes genes lived eight times longer under nutritional stress than mice with no such genes but "developed obesity and all clinical symptoms" of diabetes when fed somewhat more generously (50% of the standard lab diet).

RECENT ANTHROPOLOGY DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS I.

TERENCE E. HAYS
Department of Anthropology and Geography
Rhode Island College
Providence, RI 02908

This is the first in a proposed continuing series of compilations of information regarding recent doctoral dissertations of interest to ethnobiologists. The series is intended only to bring such work to the attention of readers of this journal; no abstracts or annotations will be provided. This list is limited to Ph.D. dissertations accepted in departments of Anthropology, acknowledging that occasionally equally-relevant dissertations (as well as master's theses) are written in a wide variety of other university departments. It is also limited to those of which abstracts are published in *Dissertation Abstracts International,* and thus to those accepted at colleges and universities which are cooperating institutions with University Microfilms International (300 N. Zeeb Road, Ann Arbor, Michigan 48106), from whom in most instances copies may be ordered.

Judgments as to substantial relevance to ethnobiology were based on inspection of the titles and abstracts published in *Dissertation Abstracts International.* In addition to those dissertations whose titles indicate an ethnobiological focus, also included are those whose abstracts suggest an emphasis on cultural ecology, subsistence, and related topics. Some judgmental errors are probably inevitable and the compiler would be grateful for corrections and additions.

For this first listing, the arbitrary starting point chosen was Vol. 41(A), 1981, and the list ends with the entries in Vol. 43(A), June, 1983. Space considerations preclude categorization and cross-listing; thus a total of 92 dissertations are simply listed below, alphabetically by author. The information provided includes: author, year of acceptance, title, number of pages, institution, University Microfilms International order number, and the volume and page numbers where an abstract may be found in *Dissertation Abstracts International.* (Canadian dissertations are not available through UMI, but their abstracts are published in *DAI;* thus they are listed here.)

ANDERSON, PATRICIA MARIE. 1982. Reconstructing the Past: The Synthesis of Archaeological and Palynological Data, Northern Alaska and Northwestern Canada. 578 pp. Brown Univ. DA8228227. 43:3638-A.

BARKER, JAMES PATRICK. 1982. Incentives, Income, and Institutions: An Inquiry into Fisheries Development in Western Samoa. 316 pp. Univ. of Calif.-Riverside. DA8223365. 43:1599-A.

BAYHAM, FRANK E. 1982. A Diachronic Analysis of Prehistoric Animal Exploitation at Ventana Cave. 425 pp. Arizona State Univ. DA8216424. 43:489-A.

BEAUDRY, MARY CAROLYN. 1980. *Or What Else You Please to Call It:* Folk Semantic Domains in Early Virginia Probate Inventories. 206 pp. Brown Univ. 8111063. 41:5153-A.

BERLIN, ELOIS ANN. 1981. Migrants to Amazonia: A Study of the Nutrition and Health of Settlers on the Santiago River, Peru. 292 pp. Univ. Calif.-Berkeley and Univ. Calif.-San Francisco. DA 8212167. 43:1212-A.

BOGAN, ARTHUR EUGENE. 1980. A Comparison of Late Prehistoric Dallas and Overhill Cherokee Subsistence Strategies in the Little Tennessee River Valley. 221 pp. Univ. Tennessee. 8108125. 41:4433-A.

BOSTER, JAMES SHILTS. 1981. How the Exceptions Prove the Rule: An Analysis of Informant Disagreement in Aguaruna Manioc Identification. 270 pp. Univ. Calif.-Berkeley. 8200031. 42:3212-3213-A.

BROWN, MICHAEL FOBES. 1981. Magic and Meaning in the World of the Aguaruna Jivaro of Peru. 268 pp. Univ. Michigan. 8116204. 42:760-761-A.

BRUDER, J. SIMON. 1982. Prehistoric Settlement and Subsistence Strategies in the Carefree Area, South Central Arizona. 530 pp. Arizona State Univ. DA8304704. 43:3357-A.

CALVERT, SHEILA GAY. 1980. A Cultural Analysis of Faunal Remains from Three Archaeological Sites in Hesquiat Harbour, British Columbia. Univ. of British Columbia. 42:2738-2739-A.

CHANG, CLAUDIA. 1981. The Archaeology of Contemporary Herding Sites in Greece. 370 pp. SUNY-Binghamton. 8121174. 42:1697-1698-A.

CHRISTENSON, ANDREW LEWIS. 1981. The Evoluation of Subsistence in the Prehistoric Midwestern United States. 307 pp. Univ. Calif.-Los Angeles. 8201079. 42:3646-A.

CLAASSEN, CHERYL PATRICIA. 1982. Shellfishing Patterns: An Analytical Study of Prehistoric Shell from North Carolina Coastal Middens. 298 pp. Harvard Univ. DA8303423. 43:3043-A.

COLLINS, JANE LOU. 1981. Kinship and Seasonal Migration among the Aymara of Southern Peru: Human Adaptation to Energy Scarcity. 359 pp. Univ. Florida. DA8213653. 43:203-204-A.

CONDON, RICHARD GUY. 1981. Inuit Behavior and Seasonal Change: A Study of Behavioral Ecology in the Central Canadian Arctic. 286 pp. Univ. Pittsburgh. 8202341. 42:3650-3651-A.

COUNIHAN, CAROLE MARIE. 1981. Food, Culture and Political Economy: An Investigation of Changing Lifestyles in the Sardinian Town of Bosa. 377 pp. Univ. Massachusetts. 8201314. 42:3651-A.

CRABTREE, PAM JEAN. 1982. Patterns of Anglo-Saxon Animal Economy: An Analysis of the Animal Bone Remains from the Early Saxon Site of West Stow, Suffolk. 394 pp. Univ. Pennsylvania. DA8217101. 43:851-A.

CRADER, DIANA CATHERINE. 1981. Hunters Alongside Farmers: Faunal Remains from Chencherera II Rockshelter, Malawi. 443 pp. Univ. Calif.-Berkeley. 8200063. 42:3210-A.

DOELLE, WILLIAM HARPER. 1980. Past Adaptive Patterns in Western Papagueria: An Archaeological Study of Nonriverine Resource Use. 382 pp. Univ. Arizona. 8108329. 41:4433-4434-A.

DOVE, MICHAEL ROGER. 1981. Subsistence Strategies in Rain Forest Swidden Agriculture: The Kantu' at Tikul Batu. 2 Vols., 1051 pp. Stanford Univ. 8201983. 42:3651-A.

DYE, DAVID HOWARD. 1980. Primary Forest Efficiency in the Western Middle Tennessee Valley. 281 pp. Washington Univ. 8103675. 41:3638-3639-A.

FLINT, PATRICIA ROBINS. 1982. The Northern Rocky Mountain Region: Environment and Culture History. 305 pp. Univ. Oregon. DA8224838. 43:2014-A.

FORBES, HAMISH ALEXANDER. 1982. Strategies and Soils: Technology, Production and Environment in the Peninsula of Methana, Greece. 514 pp. Univ. Pennsylvania. DA8227269. 43:2388-A.

FRANKE, CHRISTINA. 1982. The Kumasi Cattle Trade. 363 pp. New York Univ. DA8227183. 43:2388-A.

GAGE, TIMOTHY BLAIR. 1982. Ecological Theories of Diet and Food Production: A Case Study of Samoan Subsistence Agriculture. 262 pp. Penn. State University. DA8213303. 43:207-A.

GALM, JERRY R. 1981. Prehistoric Cultural Adaptations in the Wister Valley, East-Central Oklahoma. 274 pp. Washington State Univ. 8129967. 42:3210-A.

GEDDES, DAVID SIMON. 1980. Patterns of Animal Exploitation in the Late Mesolithic and Early Neolithic in the Aude Valley (Southern France). 358 pp. Univ. Pennsylvania. 8107747. 41:4434-A.

GRANDIN, BARBARA ELLEN. 1981. Small Cows, Big Money: Wealth and Dwarf Cattle Production in Southwestern Nigeria. 260 pp. Stanford Univ. 8108936. 41:4756-A.

GWYNNE, MARGARET ANDERSON. 1982. The Late Archaic Archaeology of Mount Sinai Harbor, New York: Human Ecology, Economy and Resource Patterns on the Southern New England Coast. 607 pp. SUNY-Stony Brook. DA8218079. 43:851-A.

HANSEN, JULIE MARIE. 1980. The Palaeoethnobotany of Franchthi Cave, Greece. 466 pp. Univ. Minnesota. 8102094. 41:3164-3165-A.

HARRILL, BRUCE GILBERT. 1982. Prehistoric Agricultural Adaptation and Settlement in Long House Valley, Northeastern Arizona. 211 pp. Univ. Arizona. DA-8217418. 43:852-A.

HECHT, ROBERT MICHAEL. 1982. Cocoa and the Dynamics of Socio-Economic Change in Southern Ivory Coast. 360 pp. Univ. Cambridge. DA8309242. 43: 3959-A.

HIDE, ROBIN LAMOND. 1981. Aspects of Pig Production and Use in Colonial Sinasina, Papua New Guinea. 705 pp. Columbia Univ. 8125303. 42:2743-A.

HILDEBRANDT, WILLIAM REID. 1981. Native Hunting Adaptations on the Northern Coast of California. 230 pp. Univ. Calif.-Davis. 8200518. 42:3647-A.

HORNE, STEPHEN PHILIP. 1981. The Inland Chumash: Ethnography, Ethnohistory, and Archaeology. 376 pp. Univ. Calif.-Santa Barbara. DA8215856. 43:490-A.

HOUSHOWER, HANS. 1982. Fishing Tree Point: Gillnetting as Work and Self-Reflection. 361 pp. Univ. Washington. DA8226544. 43:2017-A.

IRIMOTO, TAKASHI. 1980. Ecological Anthropology of the Caribou-Eater Chipewyan of the Wollaston Lake Region of Northern Saskatchewan. Simon Fraser Univ. 42:275-A.

IRIS, MADELYN ANNE. 1981. Navajo Children's Lexical Development and the Acquisition of World View. 402 pp. Northwestern Univ. 8124911. 42:2196-A.

JOHNSON, JEFFREY CARL. 1981. Cultural Evoluation and the Organization of Work: Scarcity and Resource Management in an Alaskan Fishery. 172 pp. Univ. Calif.-Irvine. DA8202914. 42:4505-A.

JUMAYEYI, YUSUF MCDADLLY. 1981. The Later Prehistory of Southern Malawi: A Contribution to the Study of Technology and Economy during the Later Stone Age and Iron Age Periods. 589 pp. Univ. Calif.-Berkeley. DA8211979. 42:5168-A.

KAHN, MIRIAM. 1980. Always in Hunger: Food as Metaphor for Social Identity in Wamira, Papua New Guinea. 325 pp. Bryn Mawr Coll. 8125525. 42:2745-A.

KENT, JONATHAN DWIGHT. 1982. The Domestication and Exploitation of the South American Camelids: Methods of Analysis and Their Application to Circum-Lacustrine Archaeological Sites in Bolivia and Peru. 645 pp. Washington University. DA8223797. 43:1598-A.

KLEIN, JOEL IRA. 1981. The Cypress Citadel and Its Role in the Subsistence-Settlement System of the Late Woodland Lewis Culture of Extreme Southern Illinois. 390 pp. New York Univ. DA8210983. 42:5169-A.

KOERPER, HENRY CARL. 1981. Prehistoric Subsistence and Settlement in the Newport Bay Area and Environs, Orange County, California. 687 pp. Univ. Calif.-Riverside. 8122913. 42:2190-A.

LAMBERT, DONALD HARLEY. 1981. Diversified Farming and Ecological Change in a Pahang Malay Neighborhood. 254 pp. Univ. Calif.-Berkeley. 8200173. 42:3214-A.

LEE, THOMAS REED. 1982. Cultural Ecology of the Middle Trinity River Basin, 1850-1970. 366 pp. Southern Methodist Univ. DA8309626. 43:3959-A.

LYMAN, RICHARD LEE. 1982. The Taphonomy of Vertebrate Archaeofaunas: Bone

Density and Differential Survivorship of Fossil Classes. 318 pp. Univ. Washington. DA8218245. 43:852-A.

McCREERY, DAVID WARREN. 1980. The Nature and Cultural Implications of Early Bronze Age Agriculture in the Southern Ghor of Jordan: An Archaeological Reconstruction. 409 pp. Univ. Pittsburgh. 8112620. 41:5153-5154-A.

McCUTCHEON, MARY SHAW. 1981. Resource Exploitation and the Tenure of Land and Sea in Palau. 278 pp. Univ. Arizona. 8117744. 42:1230-A.

McGOVERN, THOMAS HOWATT. 1979. The Paleoeconomy of Norse Greenland: Adaptation and Extinction in a Tightly Bounded Ecosystem. 413 pp. Columbia Univ. DA8204512. 42:4057-A.

MAY, JACK ALAN. 1982. Midden Formation Modeling Using Ethnographic and Archaeological Data: A Trend Surface Analysis of Midden Deposits at the Carlston Annis Site (15 MtS), Kentucky. 304 pp. Univ. Missouri-Columbia. DA8310413. 43:3955-A.

MILLER, NAOMI FRANCES. 1982. Economy and Environment of Malyan, a Third Millennium B.C. Urban Center in Southern Iran. 2 Vols., 479 pp. Univ. Michigan. DA8215051. 43:491-A.

MINNIS, PAUL EDWARD. 1981. Economic and Organizational Responses to Food Stress by Non-Stratified Societies: An Example from Prehistoric New Mexico. 366 pp. Univ. Michigan. 8116300. 42:759-A.

MOBLEY, CHARLES MURRAY. 1981. Archaic Hunter-Gatherer Settlement in Northeastern New Mexico. 241 pp. Southern Methodist Univ. 8120707. 42:1698-A.

MOORE, JAMES ANTHONY. 1981. Decision Making and Information among Hunter-Gatherer Societies. 391 pp. Univ. Massachusetts. 8201366. 42:3648-A.

NELSON, MARGARET CECILE. 1981. Chipped Stone Analysis in the Reconstruction of Prehistoric Subsistence Practices: An Example from Southwestern New Mexico. 426 pp. Univ. Calif.-Santa Barbara. DA8215867. 43:491-A.

NEUSIUS, SARAH WARD. 1982. Early-Middle Archaic Subsistence Strategies: Changes in Faunal Exploitation at the Koster Site. 389 pp. Northwestern Univ. DA8305504. 43:3358-A.

OLSEN, JOHN WILFRED. 1980. A Zooarchaeological Analysis of Vertebrate Faunal Remains from the Grasshopper Pueblo, Arizona. 377 pp. Univ. Calif.-Berkeley. 8029534. 41:3166-A.

PAINTER, MICHAEL DAVID. 1981. The Political Economy of Food Production: An Example from an Aymara-Speaking Region of Peru. 305 pp. Univ. Florida. DA-8213687. 43:205-A.

PALACIO, JOSEPH ORLANDO. 1982. Food and Social Relations in a Garifuna Village. 215 pp. Univ. Calif.-Berkeley. DA8300616. 43:2719-A.

PICCHI, DEBRA SUE. 1982. Energetics Modeling in Development Evaluation: The Case of the Bakairi Indians of Central Brazil. 451 pp. Univ. Florida. DA8302286. 43:3048-A.

PILGRAM, THOMAS KURT. 1982. Predicting Archaeological Sites from Environmental Variables: A Mathematical Model for the Sierra Nevada Foothills. 120 pp. Univ. Calif.-Berkeley. DA8300622. 43:2716-A.

POMEROY, JOHN ANTHONY. 1980. Bella Bella Settlement and Subsistence. Simon Fraser Univ. 42:4503-A.

PRATT, GARY MICHAEL. 1982. The Western Basin Tradition: Changing Settlement-Subsistence Adaptation in the Western Lake Erie Basin Region. 305 pp. Case Western Reserve Univ. 8118803. 42:1225-A.

RAI, NAVIN KUMAR. 1982. From Forest to Field: A Study of Philippine Negrito Foragers in Transition. 276 pp. Univ. Hawaii. DA8220043. 43:1215-A.

RASHFORD, JOHN HARVEY. 1982. Roots and Fruits: Social Class and Intercropping in Jamaica. 587 pp. City Univ. of New York. DA 8302539. 43:3048-A.

SOCIETY OF ETHNOBIOLOGY, INC.
MEMBERSHIP RENEWAL FOR 1984

To ensure continuous delivery of the Journal of Ethnobiology through 1984, please return this form with your payment. The journal will remain semi-annual in 1984. Backissues of the journal (Vol. 1-3) are still available and can be ordered for $17 per volume. Please make checks payable to: Journal of Ethnobiology.

_____	Regular Member	$15.00	Name and mailing address:
_____	Institutional	25.00	_______________
	Postage (foreign subscribers only except Canada and Mexico)	6.00	_______________
			_______________
TOTAL AMOUNT ENCLOSED		_____	_______________

Please return this form with your payment to the Secretary/Treasurer:

Steven D. Emslie
Department of Zoology
University of Florida
Gainesville, FL 32611

Thank you for your continued interest in the Society.

UMAR. 1982. From Forest to Field: A Study of Philippine Negrito
Transition. 276 pp. Univ. Hawaii. DA8220043. 43:1215-A.
HN HARVEY. 1982. Roots and Fruits: Social Class and Intercropping
587 pp. City Univ. of New York. DA 8302539. 43:3048-A.

REDDING, RICHARD WILLIAM, JR. 1982. Decision Making in Subsistence Herding of Sheep and Goats in the Middle East. 442 pp. Univ. Michigan. 8116322. 42:759-A.

RICHARDS, NANCY LOIS. 1980. Erythroxylon Cocoa in the Peruvian Highlands: Practices and Beliefs. 281 pp. Univ. Calif.-Irvine. 8106789. 41:4438-A.

RINDOS, DAVIS JOHN. 1981. The Origins and Spread of Agricultural Systems: An Evolutionary Perspective. 547 pp. Cornell Univ. 8129710. 42:3648-A.

SABO, GEORGE III. 1981. Thule Culture Adaptations on the Southern Coast of Baffin Island, N.W.T. 2 Vols., 715 pp. Michigan State Univ. 8202506. 42:3648-3649-A.

SATTERTHWAIT, LEONN DALE. 1980. A Comparative Study of Australian Aboriginal Food-Procurement Technologies. 459 pp. Univ. Calif.-Los Angeles. 8102876. 41:3646-A.

SCHELBERG, JOHN DANIEL. 1982. Economic and Social Development as an Adaptation to a Marginal Environment in Chaco Canyon, New Mexico. 321 pp. Northwestern Univ. DA8305519. 43:3359-A.

SCHULZ, PETER DOUGLAS. 1981. Osteoarchaeology and Subsistence Change in Prehistoric Central California. 260 pp. Univ. Calif.-Davis. 8200542. 42:3649-A.

SHRESTHA, BISHNU BAHADUR. 1982. The Prehistoric Archaeology of Nepal with Special Reference to the Beginning of Agriculture. 272 pp. Univ. Minnesota. DA-8302013. 43:2716-2717-A.

SILLEN, ANDREW. 1981. Strontium and Diet at Hayonim Cave, Israel: An Evaluation of the Strontium/Calcium Technique for Investigating Prehistoric Diets. 201 pp. Univ. Pennsylvania. 8117853. 42:1225-A.

SMITH, ERIC ALDEN. 1980. Evolutionary Ecology and the Analysis of Human Foraging Behavior: An Inuit Example from the East Coast of Hudson Bay. 690 pp. Cornell Univ. 8103010. 41:3647-A.

SOULE, EDWIN CHARLES. 1981. Agriculture, Aridity, and Salinity in the Prehistoric Moapa Valley. 256 pp. Univ. Calif.-Riverside. 8119580. 42:1226-A.

SPIELMANN, KATHERINE ANN. 1982. Inter-Societal Food Acquisition among Egalitarian Societies: An Ecological Study of Plains/Pueblo Interaction in the American Southwest. 2 Vols., 475 pp. Univ. Michigan. DA8304601. 43:3359-A.

SPONSEL, LESLIE ELMER. 1981. The Hunter and the Hunted in the Amazon: An Integrated Biological and Cultural Approach to the Behavioral Ecology of Human Predation. 518 pp. Cornell Univ. 8129634. 42:3656-A.

STAFFORD, CHARLES RUSSELL. 1981. Modeling Prehistoric Settlement-Subsistence Systems in the Forestdale Region, East-Central Arizona. 337 pp. Arizona State Univ. 8124497. 42:2191-A.

STEWART, RICHARD MICHAEL. 1981. Prehistoric Settlement and Subsistence Patterns and the Testing of Predictive Site Location Models in the Great Valley of Maryland. 448 pp. Catholic Univ. 8107982. 41:4435-A.

STUCKY, RICHARD KEITH. 1982. Mammalian Fauna and Biostratigraphy of the Upper Part of the Wind River Formation (Early to Middle Eocene), Natrona County, Wyoming, and the Wasatchian-Bridgerian Boundary. 338 pp. Univ. Colorado-Boulder. DA8229868. 43:2387-A.

SULLIVAN, SHAUN DORSEY. 1981. Prehistoric Patterns of Exploitation and Colonization in the Turks and Caicos Islands. 460 pp. Univ. Illinois-Urbana-Champaign. DA8203607. 42:5169-A.

TANNENBAUM, NICOLA BETH. 1982. Agricultural Decision Making among the Shan of Maehongson Province, Northwestern Thailand. 399 pp. Univ. Iowa. DA8229980. 43:2720-A.

TAYLOR, PAUL MICHAEL. 1980. Tobelorese Ethnobiology: The Folk Classification of "Biotic Forms." 480 pp. Yale Univ. 8109818. 41:4760-A.

THIEL, BARBARA JEAN. 1980. Subsistence Change and Continuity in Southeast Asian Prehistory. 198 pp. Univ. Illinois-Urbana-Champaign. 8108685. 41:4754-A.

TRAKAS, DEANNA JEANNE. 1981. Favism and G6PD Deficiency in Rhodes, Greece: The Interaction of Environment, Inheritance and Culture. 382 pp. Michigan State Univ. 8117272. 42:766-A.

WASELKOV, GREGORY ALAN. 1982. Shellfish Gathering and Shell Midden Archaeology. 381 pp. Univ. North Carolina-Chapel Hill. DA8222909. 43:1598-A.

WESSEN, GARY CHARLES. 1982. Shell Middens as Cultural Deposits: A Case Study from Ozette. 292 pp. Washington State Univ. DA8301345. 43:3045-A.

WHITLAM, ROBERT GEORGE. 1981. Settlement-Subsistence System Type Occurrence and Change in Coastal Environments: A Global Archaeological Perspective. 235 pp. Univ. Washington. 8113481. 42:270-A.

WILK, RICHARD RALPH. 1981. Agriculture, Ecology and Domestic Organization among the Kekchi Maya. 582 pp. Univ. Arizona. 8200327. 42:3218-A.

ZALUCHA, LEONARD ANTHONY. 1982. Methodology in Paleoethnobotany: A Study in Vegetational Reconstruction Dealing With the Mill Creek Culture of Northwestern Iowa. 384 pp. Univ. Wisconsin-Madison. DA8304976. 43:3640-A.

BOOK REVIEWS

In the realm of book reviews there seem to be two major approaches, the synopsis and the critique. The book review editors of the *Journal of Ethnobiology* want to encourage both formats. The review policy of the *Journal* is still evolving, and we will try to make it as flexible as possible to meet new situations as they arise. Dr. Bahr's review of *Once A River* raised several provocative issues to which we asked Dr. Rea to respond. We hope the result is a dialogue that will be of interest to our readers.

CHM & RSF

Once a River, Bird Life and Habitat Changes on the Middle Gila. Amadeo M. Rea, with sketches by Takashi Ijichi. Tucson: University of Arizona Press, 1983. xiv + 285 pp. $24.50.

The editors asked that this review concentrate on the linguistic and more broadly the ethnographic aspects of Rea's fine book. As will be seen, I think its strength lies not so much in that aspect, but rather in its patient and scientific answer to the question, "What was the effect on birds of the historic man-caused stopping of the Gila River?" An ornithologist, Rea inventoried the occurrence of Linnaean bird types (order, family, genus, species, subspecies) on a particular tract of land (the Gila River Pima-Maricopa Indian Community) located in central Arizona. He related species of birds to particular habitats and seasons on the Reservation. Most important, he demonstrated changes in those distributions over a 150 year period in which the Gila River was made to dwindle and die on the Reservation.

Ethnography and linguistics entered the project through the use of old (not young) Pima (not Maricopa) residents to provide native names for bird skins already identified by Linnaean species, to comment on the habits and occurrence of the species (in other words, to recall how they experienced the birds), and to comment on changes they had observed through their lifetimes. The residents were from a part of the reservation where aquatic habitats had persisted the longest and where Rea had made friends as a biology teacher. The book is divided in two parts, one dealing with habitat and species changes in general, the other, called "Species Accounts", dealing with what was known historically, ethnographically, and ornithologically about each species.

By my count, 249 species are treated in the second part. Of these, 71 were found to have Pima names. The species represent 19 Linnaean orders and 61 families, by my count. No relations of class inclusion are indicated for the Pima taxa, except that all 71 of them are included under the class *u'uhig*, 'bird'. Seventy-one bird taxa are many, when compared with any previous list from the Pima-Papago (the two tribes are essentially of one culture and language), but it is not many when compared with two other well studied tribal peoples (both from New Guinea) cited by Berlin, Breedlove, and Raven in their survey article on principles of classification and nomenclature in folk biology (1973). According to them the Karam, studied by Ralph Bulmer, have 181 taxa under the heading *Yakt*, 'birds and bats', and the Fore studied by J.M. Diamond have 110 taxa under *Kabara*, 'birds'. I suspect that a Pima study making use of Berlin *et al.'s* hypotheses about taxonomic levels would probably find more levels than Rea did. When I say the strength of the book is not in its ethnography, I mean that there are comparative studies on folk taxonomies, exemplified by Berlin *et al.*, and this book doesn't consider them.

As stated, it appears that Rea's method of securing native names was to take skins to natives and ask, "Do you have a name for this?" Of the 249 species that he recognized and had names for, they recognized and had names for 79, about a third. Apparently he didn't work into the native taxonomy by persistently asking in Pima, 'What are the kinds of X?' One prior student, Madeleine Mathiot, made such a study and published a suggestive analysis of the noun classes in which Papago bird taxa fall (1964). This research was not followed up, and although such a study would be ethnographically relevant, it was not needed in order to answer the ornithological or ecological question on the effect on birds of the stopping of the river. Pima taxonomics have nothing to do with that question.

I will contrast Rea's study with one more model ethnographic work, namely Salinas' and Bernard's *Rc Hnychnyu, The Otomi* (1978). This book is called a "monolingual ethnography" because every word in it was first written by Salinas in Otomi (a Mexican Indian language), then translated as literally as possible by Bernard into English. It contains a section on birds with 28 essays averaging about 400 words each, on 28 Otomi bird species. Basically these are birds as seen by a young male, Mexican, Indian, peasant, school teacher. Twenty-eight species names are fewer than Rea, Bulmer or Diamond obtained from their intentionally exhaustive investigations into native cultures, and they are probably far fewer than a Western ornithologist would identify among the Otomi. Ah, but what accounts they are, and how much richer in discourse than anything from a Pima in *Once a River*. For example:

> 336. The *cenzontle* (=mocking bird). This is a long, thin bird, grey on the back with white on its wings. It has a long tail which it fans out beautifully when it sings. Its song is pretty because it combines its song with that of other birds. In other words, it mimics other birds. It imitates the sparrow, the *huitlacoche*, the *calandria*, the lark, the cardinal, and even people if it hears them whistle . . .
> 341. As I said before, it is much desired in the market for its song. People pay 20 pesos for one of these birds. The merchants shout in the market to attract attention. Some people pay 15 pesos . . . I've heard that they are sold in big cities for up to 40 or 50 pesos each. (p. 94).

It would be good to have such a book or books from Pimas telling what they really think and know about birds: young Pimas, old Pimas, bird lovers and bird haters. Does Joe Pima know more about birds than Joe White who lives in Phoenix?

Rea answers his ornithological questions as follows. He divided the present reservation habitats into eleven types. Some are types with multiple places, e.g., "Mountains," "Floodplains", and "Mechanized Farms." Some are unique places but have the potential to be duplicated within or outside the reservation, e.g., "Chandler Boundary Cottonwoods" and "Barehand Lane Marsh". Each habitat was surveyed for the kinds of numbers of birds it had in various seasons and years. Each is discussed in regard to its endangeredness, that is, whether peoples' activities in the 1970's and '80's were making serious changes in the habitat and whether those changes affected bird life.

The answer is complex. Rea points out that aquatic environments are now the most dynamic (i.e., changing) on the reservation. There are only a few riparian habitats left and those patches are not watered by the Gila River. One that he studied intensively is a small marsh formed from the runoff of agribusiness fields—its water is pumped from the ground. Another's water comes from the Phoenix Sewer Plant. Both habitats suffered various calamities over the nearly 20 years that Rea followed them, and both show an amazing ability to come back, first with plants in a certain order, then with birds who use those plants.

Taking all birds and habitats, Rea considers that 29 species no longer occur even as dependable visitors to the reservation. Twenty-five of these required aquatic habitats. Another 24 species are greatly reduced, again mostly lovers of water or of vegetation that grows along water. Combined, these represent a fifth of the ornithologist's original 240-odd species. (Other species are increasing or have arrived since the 1850 baseline: cowbirds, house sparrows, pigeons, a kind of vulture, two kinds of hummingbird, and more). Assuming that the Linnaean species for which Pimas had names are culturally more important than those for which they didn't have names, I checked the proportion of Pima-named against the whole 249. The proportions are about the same (9 of 29 against 71 of 249). This suggests a negative conclusion, but one very remote from the heart of the matter if that heart is considered to be the human significance of the loss of the birds. The negative conclusion is that the removal of the river did not remove a disproportionate number of native named birds. The remoteness is that names, present or absent, remembered or forgotten, are not articulated thoughts or feelings. Names (nouns) are not sentences, tabulations of names are not essays.

This may be a difference between ethnography and ornithology, that the latter concerns facts about the birds and the former, mistakenly or not, concerns their human significance. In concluding there is less ethnography than ornithology in this book, I don't mean to slight the latter or to say that the former necessarily should have been pressed farther. It is Rea's book, it took a lot of real work, and I recommend it, especially the parts on the resurrection of the marshes.

I will close on a strictly linguistic matter. Practically the only linguistics in the book are concerned with the hearing and spelling of Pima bird names. Rea heard and hence spelled many names differently from the several linguists (including possibly myself) who have studied primarily on the "Papago" side of the Pima-Papago language. He believes Pima has some phonemes which no one else has yet recognized for Pima-Papago. This is a technical matter which is not resolved with proper linguistic evidence in the book. Personally I am skeptical of many of Rea's hearings and spellings, including his extra phonemes. To give a non-bird example from the book, because it involves a fairly common word, to spell 'many saguaros' as *s'hawshunek* instead of *s-hasanig*, whether in Pima or Papago, strikes me as plain wrong not so much because of the diacriticals but because of the vowels.

Donald M. Bahr
Department of Anthropology
Arizona State University
Tempe, Arizona

References Cited

BERLIN, B., D. BREEDLOVE, and P. RAVEN. 1973. General Principles of Classification and Nomenclature in Folk Biology. Amer. Anthropol. 75:214-242.

MATHOIT, M. 1964. Noun Classes and Folk Taxonomy in Papago. Pp. 154-163 *in* Language in Culture and Society. D. Hymes, Ed. New York: Harper and Row.

SALINAS PEDRAZA, J., and H. BERNARD. 1978. *Rc Hnychnyu, The Otomi, Vol. 1: Geograph and Fauna.* Univ. New Mexico Press, Albuquerque.

Reply to Bahr

The book review editors have asked me to respond to Don Bahr's review of my book, Once A River, Bird Life and Habitat Changes on the Middle Gila.

An author can only hope that a reviewer will evaluate a book on how successfully it fulfills its stated objectives rather than on the basis of some tangents that the reviewer himself might have pursued had he been writing a somewhat similar book. My objectives are almost skeletally explicit in the introduction: "This book examines the microcosm of the Gila River Indian Reservation and focuses on minute details of specific avian habitats and of ecosystem deterioration" (p. 3) and "In a minutely detailed manner this book attempts to present what is known of the interactions on the middle Gila of human cultures, water regimes, plant communities, and birds in the recent historic past, and especially in the 1960s and 1970s." The attempt is to understand the river as an *ecosystem*, one that has been modified by three human cultures: Indian, Hispanic, and Anglo. Some of the tools used in this historical reconstruction include Piman terminal folk taxa and ethnohistorical accounts. The limitations of the ethnographic data included are recognized: "There is a richness of symbolism only hinted at here. Explication of the deep cultural significances of animals will require a separate work" (p. 117, introduction to species accounts).

Bahr is quite right that there are some aberrant spellings of Piman terms. When the book was in page proof, the Press urged me to convert my orthography from the I.P.A. system I had used for a decade to that of Alvarez and Hale, now almost universally used by Papago. This compromise, coming in the midst of prescheduled filed work, left me scarcely 48 hours to search for Piman terms, transforming various vowels such as e, i, and u. Some were missed. I would certainly agree with Bahr's spelling of 'saguaro' and essentially his spelling can be found on pp. 34 and 285. I am more chagrined at *akimel*, 'river' (part of the self-designation of the River Pima), remaining as *akimul* on pp. 9 and 256. But I am not a linguist and am sure that there are other transcriptions due to faulty hearing, particularly of e and u.

My several additional River Pima phonemes were not defended in traditional linguistic manner (i.e., by contrasts in the same or similar sound environments). But I must decline the honor of claiming that "no one else has ever recognized" these. All my phonemes (and more) can be found on p. 16 and throughout Frank Russell's classic ethnography of the Pima (1908, reissued 1975). Too, there are regional variations in words even *within* Riverine Pima, as some careful consultants will point out. My point is that just as careful attention to subspecific variation in birds is a major tool to studying their migrations, so too regional variations within the widely dispersed Piman speaking groups might be of some aid to tracing the protohistoric peregrinations of these interesting people (see p. 256).

Numbers must be used cautiously. My book includes only 18 orders and 51 families of birds, not 19 and 61, respectively. The suggestion that the loss of the river did not remove a disproportionate number of named terminal taxa seems to me unlikely. Surely such visually distinctive or vocally conspicuous *breeding* birds as the Green Heron, Common Yellowthroat, Long-billed Marsh Wren, Common Gallinule, Song Sparrow, Black Phoebe, Least Bittern, and the several rails must have once been named in the Pima lexicon. We began asking questions about a century too late to accurately evaluate the full importance of riparian flora and fauna in the lives of these people.

To compare the Pima ethnoornithology numerically to that of the New Guinean highlands is misleading for several reasons. As is well known, tropical ecosystems are considerably more diverse than temperate ones (including deserts). The New Guinea natives have virtually intact cultures and environments, while the Pima have suffered a century of deculturation and major degradation of their biotic community. New Guineans are dealing almost entirely with a resident avifauna. If one eliminates all transient, rare, casual, accidental, erratic, and sibling species (those such as certain flycatchers requiring careful in-hand comparison to distinguish), there remain about 102 species on the Middle Gila that the Pima might have *regularly* encountered as either breeding birds or winter residents before habitat deterioration. Of these, they distinguish at least 71 terminal folk taxa, about 70% of the biological species.

The correct identification of avian ethnotaxa is a complex matter involving criteria such as behavior, vocalizations, nesting habitats, and habitat preferences as well as morphology. Bahr's surmise that I worked only or even primarily from skins (morphology) in eliciting ethnotaxa is incorrect. (He happened along one of the few times I did, over a decade ago.) Actually, hundreds of hours were spent in the field with older Pimans who were mobile. This should be evident from the accounts of the Harris' Hawk, Ground Dove, Yellow-billed Cuckoo, Say's Phoebe, Common Raven, and Curve-billed Thrasher, to mention a few.

Once A River does not deal with folk hierarchies, and need not, as Bahr notes. But I wonder if such hierarchies may serve primarily to satisfy the needs of western anthropologists? How many of the so-called covert categories truthfully represent anything in the natives' conceptualization and how many are logical gymnastics on the part of the investigator? Do Papago really have an unlabeled category whose referents are the porcupine and tortoise (Pilcher 1967)? Recently, while trying to group terminal folk plant taxa for a Pima ethnobotany, I tried out both Mathiot's (1962) and Pilcher's Papago higher categories with two Pima I've been working with for two decades. Most categories they denied for the Pima. Some they said, "Well, Papago would say it that way, but we don't." Others they said were sliding categories, with an individual plant being categorized differently according to circumstances—as if someone plants it or it just came up as a volunteer. Asked for a better arrangement, they grouped plants by how they were used, putting even biological congenerics into different divisions. Elicitation is still in an early stage, but it appears that utilitarian factors are quite important to how Pima organize groups above the level of terminal taxa (see Hunn 1982 and Hayes 1982 for critical discussions of this concept). The Pima taxonomic "tree" may be scarcely more than a bush.

This brings me back to Pilcher's (1967) Papago labeled higher category of 'bird' *u'uhik* (or *u'uhig),* which reportedly includes *only* flying critters and therefore excludes *chuchul,* 'chickens.' Some days after our sessions on the proposed Papago categories, Sylvester Matthias, a Pima, reminded me that when Phoenix ranchers in the 1890s and 1900s began raising ostriches, the Pima called the new stock *ge:'ichu u'uhik* or 'great birds.' Perhaps this higher category business has gotten us little further along the beach than Lewis Carroll's "The Walrus and the Carpenter," which is intended to be merely delightful.

Amadeo M. Rea
Natural History Museum
San Diego, California

REFERENCES CITED

HAYES, T.E. 1982. Utilitarian/adaptationist explanations of folk biological classification: some cautionary notes. J. Ethnobiology 2:89-94.

HUNN, E. 1982. The utilitarian factors in folk biological classification. American Anthropologist 84:830-847.

MATHIOT, M. 1962. Noun classes and folk taxonomy in Papago. American Anthropologist 64:340-350.

PILCHER, W. W. 1967. Some comments on the folk taxonomy of the Papago. American Anthropologist 69:204-208.

RUSSELL, F. 1908. *The Pima Indians.* Re-edition with introduction, citation sources, and bibliography by B. L. Fontana. 1975. University of Arizona Press, Tucson.

Le Cheval dans la view quotidienne; techniques et representations du cheval de travail dans l'Europe industrielle. Bernadette Lizet. Berger-Levrault (Espace des Hommes), Paris, 1982. 214 pp., ill., bibliogr.

The subtitle of this book, *"Techniques et representations du cheval de travail dans l'Europe industrielle"*, indicates the chronological and geographical limits the author felt obliged to impose on the wealth of materials she has collected on the horse and its place in everyday life. Her careful analysis of numerous historical sources is completed by extensive information derived not only from her personal experience with horses but also from years of field work in regions where these animals are still employed. Avoiding facile bucolic scenes of the plowman and his shire and hackneyed caricatures of the ruthless coachman and his scrawny nag, Lizet has undertaken to describe how horses lived and worked, in the fields and the mines, on the roads and the canals, at a time when they represented the principle source of energy for agriculture, trade and industry. All the aspects of their existence are considered, and we learn how they were bred and trained, shoed and harnessed, stabled and fed, bought and sold, and eventually slaughtered and and even eaten. The wide range of professions associated with each phase of equine life is also depicted. The author introduces us to farmers, miners, barge-men and omnibus-drivers as well as to horse-dealers, farriers, saddlers and knackers; explaining their specialized lores, analyzing their economic, social and sentimental relationships with the animals they used and served. We are also given a glimpse of the conflicts that arose when certain administrators, veterinarians or agronomists, eager to maximize productivity, sought to replace traditional knowledge and practices with genetic and technological "improvements". The text, enlivened by exerpts from 19th century treatises on horse management and interviews with some of the surviving professionals of the period, is abundantly illustrated. In addition to photographs from her personal collection, the author presents us with a fascinating array of illustrations, including reproductions of appropriate paintings, drawings and engravings as well as amusing pages from catalogs and instruction manuals published near the turn of the century, all of which she selected and organized herself.

The book begins with a brief look at the origins and evolution of the genus *Equus* and at the behavior of animals living in the wild, before mentioning the controversy over when, where and why the horse was first domesticated. The next section outlines man's relationship with this animal from Ancient Times up to the 19th century, explaining the various ways it was used and cared for.

The most important section of the book is devoted to "living and working with horses". The choice made by the author to organize her material according to the different phases in a horse's life and to its physical and human environment, rather than according to specific breeds or careers (e.g. farm animals, pit ponies, coach cobs), enables her to focus on the equine condition in general, while facilitating comparisons among the various kinds of work animals.

The first chapters discuss horse-fairs and horse-dealers, explaining the criteria used for selecting an animal, the rituals of buying and selling as well as the "tricks of the trade". Once a horse has been acquired, it is often subjected to certain "operations" designed to make it more suitable for its functions or simply conform to esthetic ideals (e.g. docking, nicking, castrating, ear-trimming). Training is the next significant episode in a horse's life explored by Lizet. Commands and requirements vary from one task to another but what is remarkable in almost all cases is the rapidity and willingness with which the horse learns to obey its new master. Next we find out how shoes and harnesses must be adapted to both the individual and the type of work it is to accomplish.

Once the horse is fitted out, it is put to work, and the chapter entitled *"Le Travail"* treats the wide range of ways horses have been employed, what has been expected of them and how they have fared in their different tasks. It was not until the latter half of the 19th century that public attention was drawn to the plight of omnibus-horses, pit ponies and others, and that societies were formed and laws promulgated to combat the misery and mistreatment of certain work-horses.

The following chapter, devoted to grooming, shows how practices are influenced not only by the type of activities the animal performs but also by its socio-economic environment, current theories of hygiene and odd and sundry fads. The furnishings and implements of a well-run stable are described and pictured, and the responsibilities and qualities of grooms and other stable help are mentioned. In the chapter on food, Lizet explains how diets vary according to the region, the season and the type of effort required as well as to traditional beliefs and scientific theories.

The myths, rituals and techniques associated with mating provide the material for another brief but informative chapter. Next the author discusses what happens when a horse falls ill, showing how the treatment it receives depends not only on the disease but also on the beliefs and pharmacopoeia of the region. *"La Mort"* describes the fate of the incurable, the injured and the aged and also that of their remains (e.g. horse-meat, raw materials for agriculture and industry).

The industrial progress to which the horse had so extensively contributed during the 19th century was inevitably the source of its downfall. First, the Iron Horse threatened the live animal's supremacy, for with the development of railroads, horse-relays became obsolete. Soon urban transportation companies adopted motorized vehicles, and the last horse-drawn omnibus left the streets of Paris in 1913. Farm horses gave way to tractors and the whole structure of agricultural production was profoundly altered. The disappearance of the workhorse sounded the death knell for all the professions and crafts that had flourished during its reign.

After this short section depicting the end of the "Horse Age", Lizet presents a realistic appraisal of the problem of the work-horse today: should it be considered as "relic or revival"? Motivations for its comeback are not only economic (i.e. a growing awareness of the energy crisis); its companionship is also an important factor in preferring an animal to a machine. A return to their generalized employment is obviously out of the question, but work-horses still exist and can still be of use, as the photographs in this section amply prove.

An impressive 8-page bibliography hints at the vast amount of literature the author has consulted. The thematic classification makes it somewhat difficult at times to locate the complete reference of a title cited in the text, but for someone interested in a particular aspect (e.g. origins, behavior and domestication; shoeing and harnessing; folklore), it furnishes a solid basis for further research. For the non-specialist, a glossary would have proven helpful, regrouping various technical terms (most of which are defined at some point in the text or in foot-notes), as would several simplified diagrams of a horse and various kinds of harnesses, indicating the terms used for the different parts. Unfortunately, as in all too many French publications, an index is lacking.

But these minor technical flaws in no way detract from the overall impact of this work. Not only does it provide the reader with a wealth of beautifully illustrated historical and ethnographical information, but by reflecting the author's deep love and understanding of horses, it also makes us more aware and appreciative of all the ways this animal has contributed to our civilization. A most valuable book for ethnozoologists, horse-lovers and everyone interested in discovering a crucial period in European history from an unfamiliar angle.

Ann Cooper
Laboratoire d'Ethnobotanique et d'Ethnozoologie
Museum National d'Histoire Naturelle
Paris, France

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed doubled-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses*, i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Department of General Biology
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

With Volume 3, Number 1, the editors of the *Journal of Ethnobiology* added a book review section. We welcome suggestions on books to review or actual reviews from the readership of the *Journal*. Please send suggestions, comments, or reviews to Charles H. Miksicek or Richard S. Felger, Office of Arid Lands Studies, University of Arizona, Tucson, Arizona 85721.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Steven D. Emslie, Department of Zoology, University of Florida, Gainesville, Florida 32611. Subscription rates are $25.00, institutional; $15.00 regular members, for U.S., Canada, and Mexico; foreign subscribers add $6.00. Write checks payable to *Journal of Ethnobiology*. Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

CONTENTS

Journal of Ethnobiology

VOLUME 4, NUMBER 1

MAY 1984

Journal Organization

Journal of Ethnobiology is published semi-annually. Manuscripts for publication and information for the "News and Comments" section should be sent to the appropriate editor as explained on the inside back cover of this issue.

ISSN 0278-0771

Journal of Ethnobiology

VOLUME 4, NUMBER 1 MAY 1984

The cover design represents a split-twig figurine, made perhaps of a squawbush *(Rhus trilobata)* or willow *(Salix)* switch. Split-twig figurines appeared as a cultural trait in the American Southwest about 2000 B.C. among Archaic hunting and gathering populations in the Grand Canyon area of Arizona. They have also been found in Utah, Nevada and California, and are thought to have had some magical/religious significance concerning hunting practices. For more information see an *American Antiquity* article by Alan R. Schroedl (1977, Vol. 42(2):254-265).

KRA

SKETCHES IN THE SAND

It is April, and spring is just now making its debut in two southeastern Arizona riparian habitats at elevations of 5000-6000'. As I sit reviewing my notes for the day, I sense the flow of cold air down canyon sides and into depressed basin areas. In reaching for my sweater I partly understand the delayed emergence of leaves and flowers in streamside and marsh, when compared to nearby warmer upland slopes. With the exception of willow *(Salix)* and cottonwood *(Populus)* catkins, some newly emerging tender leaves, and the underground rootstocks of cattail *(Typha)*, these wetlands offer few edible plants for humans in the early months of the year.

For one used to picking tiny seeds out of samples of soil from archaeological sites, or attempting to identify microscopic unknowns (such as termite fecal pellets!), studying an entire habitat and its plants is a refreshing exercise that alleviates myopic vision. Examining a complete plant in context—where it grows, how it grows, its relationship to other vegetation—provides insight helpful in interpreting the ancient plant record. One is better able to relate to decisions humans had to make when seeking out useful plants.

For the past year I've been monitoring the phenology of over 100 riparian plant species known from ethnological literature or suggested in archaeological reports as being potentially important to humans. The general plant activity level at my two observation sites has dictated the frequency of visits; in the fall it was necessary to return every week to update my records, whereas from January to April general dormant conditions have continued to prevail between visits spaced a month apart.

At each visit separate standardized notations on phenological events are routinely made on leaf, stem, flower and fruit of all plants monitored. For example, in looking at the fruit of a species, I note whether (a) fruit is immature, (b) fruit is mature, (c) prior season's fruit is still clinging or (d) fruit is absent. An ultimate goal of this research is to develop a basic chart outlining the seasonality of plants in these two places, and thus better understand when and how prehistoric humans might have found wetlands economically productive over the course of a year.

As data gathering continues, I am intrigued by some preliminary seasonality patterns relating to reproduction, and especially to the persistence of edible parts. For example, although the caryopses (grains) of bristle grass *(Setaria geniculata)* and sour fruit of lemonade berry *(Rhus trilobata)* were only briefly available for harvest in the fall, the sweet berries of golden current *(Ribes aureum)* clung for up to three months after ripening. Different species of sedges (Cyperaceae) and rushes (Juncaceae) were represented in sequential reproduction from early June till late October. Some members of the Compositae (sunflower) family experienced a prolonged season of simultaneous flowering and fruiting that covered 16 weeks. In prehistory, humans visiting riparian habitats would undoubtedly have known upon which plants to concentrate their harvesting efforts; poor timing could have been costly in terms of lowered return for travel effort.

Human use of riparian plants poses the possibility that pollen could be carried into dwellings on harvested parts. Could the shriveled flowers still attached to the inferior ovary of currents *(Ribes)* provide a mechanism for pollen transport? A smooth fruit coat should preclude carrying grape *(Vitis)* pollen on grapes brought to a meal. As part of this research, these hypotheses will be tested by looking for pollen in water washed over specific plant part harvests.

Ultimately I hope to have sketched, though perhaps not in the sand, a bit of the natural history of Southwestern wetlands. Possibly a contribution in understanding pollen transport into human habitations will also emerge. Whatever happens, it is a type of sketching that is its own reward, and will leave me renewed to again tackle the Lilliputian world of seeds and plant parts from ancient dwellings.

KRA

J. Ethnobiol. 4(1):1-13 May 1984

BETWEEN THE GORILLA AND THE CHIMPANZEE: A HISTORY OF DEBATE CONCERNING THE EXISTENCE OF THE *KOOLOO-KAMBA* OR GORILLA-LIKE CHIMPANZEE

BRIAN T. SHEA
Department of Anthropology and Cell Biology & Anatomy
Northwestern University
2006 Sheridan Road
Evanston, IL 60201

ABSTRACT.–The taxonomic scheme proposed in 1934 by Ernst Schwarz for the subspecific classification of common chimpanzees *(Pan troglodytes)* has been accepted by the majority of subsequent primatologists. A notable exception to this general trend is that the late W. C. O. Hill continued and revived a long history of controversial debate over the existence of a rare gorilla-like chimpanzee subspecies known as the "kooloo-kamba." The history of the enigmatic kooloo-kamba is reviewed here, from its early discovery and description by DuChaillu, through the morphological investigations of Keith, Schwarz, Merfield, and others, and finally to the more recent claims of Hill. Almost all claims supporting the existence of the kooloo-kamba have invoked indigenous labels and folk taxonomies as evidence. The prolonged debate provides insights into the relationships between folk taxonomies and our own classifications. Confusion, variation, and the use of intermediate or hybrid categories in both Western and indigenous classifications probably reflects a salient biologic fact–gorillas and chimpanzees are very closely related animals with patterns of morphological development which coincide and overlap.

INTRODUCTION

During the late 1800s and early 1900s, a large number of chimpanzee and gorilla species were described by various workers, often on the basis of a particular variation of facial coloring, hair distribution, or cranial shape. In his classic 1913 monograph on the primates, D. G. Elliot listed two genera, two species, and an uncertain number of subspecies of gorillas; he tentatively divided the chimpanzees into eleven different species and an unknown number of subspecies. Paul Matschie recognized eight species of gorillas, and *added* nine chimpanzee species to Elliot's list (Wendt 1959). Rothschild (1904, 1906), Matschie (1904, 1919), and others created or discussed scores of potential species and varieties of chimpanzees and gorillas during this period. Stiles and Orleman (1927), Allen (1925), and Allen (1939) provide useful summaries and synonyms for this taxonomic chaos.

In their review of the great apes, Yerkes and Yerkes (1929) could add little to Elliot's (1913) summary. As Coolidge (1929) had done for the gorillas, however, Ernst Schwarz (1934) tackled the classificatory confusion within the genus *Pan*, ultimately dividing the genus into one species and four geographical subspecies. Except that many now view the bonobo or pygmy chimpanzee *(Pan paniscus)* from south of the Zaire River as a distinct species, most subsequent authorities have accepted the Schwarz taxonomy. A notable exception in this regard is that W. C. O. Hill (1967, 1969a) followed a series of earlier investigators in claiming that two kinds of chimpanzees exist in the area of equatorial Guinea and Gabon (Fig. 1), one of these being a "gorilla-like" chimpanzee form, usually referred to as the "kooloo-kamba," its name being an onomatopoeic derivative of its supposedly distinct call.

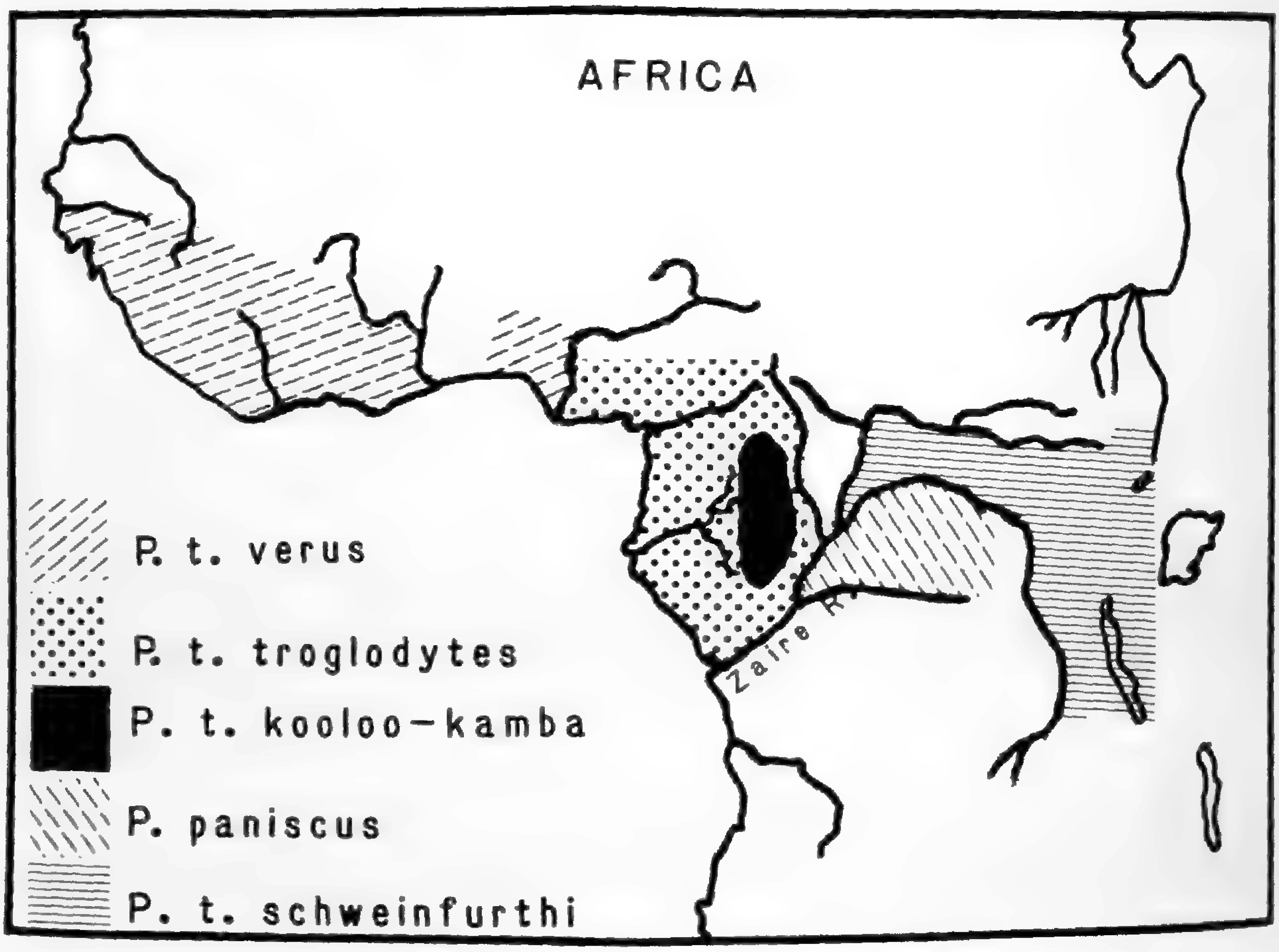


FIG. 1–(after Hill 1969a). The geographical locations of the four subspecies of *Pan troglodytes* recognized by Hill. The pygmy chimpanzee *(Pan paniscus)* is a distinct species found south of the Zaire River.

In this paper, I present a brief account of the century-long debate over the existence of the kooloo-kamba and other forms claimed to be intermediates or hybrids between the gorilla and chimpanzee, giving particular attention to the role of indigenous labels and folk taxonomies in this discussion.

BACKGROUND AND EARLY HISTORY

The kooloo-kamba was "discovered" and first described by the explorer Paul DuChaillu after his forays into equatorial Africa in the 1850s. His account of the discovery of this creature can be found in his well-known and controversial book entitled *Adventures in the Great Forest of Equatorial Africa* (1890), which is a revised edition of an earlier book. DuChaillu (1890, p. 290) wrote:

> We had hardly got clear of the bashikouays [ants] when my ears were saluted by the singular cry of the ape I was after. 'Koola-kooloo, koola-kooloo,' it said several times. Gambe and I raised our eyes, and saw, high up in a tree-branch, a large ape. We both fired at once, and the next moment the poor beast fell with a heavy crash to the ground. I rushed up, anxious to see if, indeed, I had a new animal. I saw in a moment that it was neither a *nshiego-mbouvé* [another of DuChaillu's apes], nor a chimpanzee, nor a gorilla.

DuChaillu's (1860) description of the morphology of this "chimpanzee-like animal" included a round head and face with high, well-developed cheekbones, jaws which were less prominent than in any of the other apes, large ears, and a bare, black face. The most distinctive feature of the ape supposedly was its cry, resembling the sound "kooloo."

DuChaillu (1860) reported that some Africans referred to this creature as the kooloo-kamba, loosely meaning "that which speaks kooloo." The only information which he could obtain about the habits of the animal was that it lived in the mountainous interior and was shy and rarely encounted. The skull of DuChaillu's animal is housed in the collections of the British Museum of Natural History, and it is pictured in Figure 2.

FIG. 2–(from Short 1980). Lateral and frontal views of the skulls of DuChaillu's kooloo-kamba, left (BMNH No. 1861.7.29.10) and a specimen of *Pan troglodytes troglodytes*, right (BMNH No. 1864.12. 1.7). With permission of R. V. Short and Journals of Reproduction and Fertility, Colchester, UK.

Earlier references had been made to the possibility of two chimpanzee forms in this area of western Africa, one of which was claimed to be intermediate between known chimpanzees and gorillas. The earliest reliable reference to chimpanzees and gorillas is the account of Batell (ca. 1600, Huxley 1863) describing the large ***Pongo*** and the small ***Encego***. An account by a British merchant given in Lord Monboddo's (1773) *Origin and Progress of Language* has been noted by Reade (1864), however, and it is interesting in that it mentions *three* species or types of manlike apes in western Africa: the gorilla (or ***impungu***), the chimpanzee (or ***chimpenza***), and a third ape intermediate between these (the ***itsena***). Franquet (1852) also claimed that two distinct chimpanzee species inhabited the coast of western Africa in the area of Gabon. He called these species the chimpanzee and the ***N'tchego***, the former having a brown face and large ears, the latter with a black face and small ears, as in the gorilla. Duvernoy (1855) examined a skeleton of Franquet's (1852) ***N'tchego***, and he concurred with Franquet's (1852) conclusion that it was a distinct species. Geoffroy Saint-Hilaire (1857) stressed caution, however, and suggested the possibility that the morphological distinctions being used for the species separation were only differences of sex or age. DuChaillu (1860) claimed that Franquet's (1852) *N'tchego* was in fact an adult chimpanzee, noting (correctly) that facial color in chimpanzees seems to darken with increasing age. Thus, DuChaillu's opinion was that Franquet's *N'tchego* was not the same as his own kooloo-kamba. This early confustion and lack of agreement characterizes the entire century-long discussion of the kooloo-kamba and other gorilla-like chimpanzees.

Although DuChaillu never suggested that his kooloo-kamba was the product of chimpanzee-gorilla hybridization, others forwarded this hypothesis in an effort to account for the reports of supposedly intermediate forms. German game hunter H. von Koppenfels (1881, 1887) claimed he had observed gorillas and chimpanzees interacting in their native habitat, and suggested that male gorillas and female chimpanzees unquestionably interbred. Meyer (1881) discussed actual specimens purported to be hybrids, but concluded that they were merely chimpanzees, however. One expert on the apes, Robert Hartmann (1885), was undecided concerning the issue of hybridization, and suggested that DuChaillu's kooloo-kamba and Duvernoy's (1855) *N'tchego* be considered subspecies or species intermediate between the chimpanzee and the gorilla.

Zoologist Ralph Garner (1896) was among the first to systematically observe primate behavior in the wild. In the late 1800s, Garner studied the behavior of gorillas and chimpanzees in equatorial Africa from the safety of a cage. (Although ethologists find they need no such protection when observing ape behavior, Garner was working in a time still smarting from the horrific exaggerations of DuChaillu and other "explorers".) Garner (1896) maintained that the kooloo-kamba and "common" chimpanzee were well-defined forms which were not at all difficult to distinguish while alive (which suggests he relied on inferred behavioral rather than morphological differences). In addition, British anatomist W. L. H. Duckworth (1898) reported on an ape specimen in his possession which was difficult to label either a gorilla or a chimpanzee. He concluded that the creature was a representative of DuChailuu's kooloo-kamba, noting that its large size provided some claim to an intermediate position between the chimpanzee and the gorilla. Yerkes and Yerkes (1929) reviewed the debates over the kooloo-kamba, hybridization, and intermediate gorilla-like chimpanzees. They doubted, but did not entirely reject, the possibility of gorilla-chimpanzee interbreeding, and concluded that confusing intermediate specimens which were difficult to classify reflected the close genetic relationship between these apes.

In 1938, Raingeard reported on specimens which he claimed represented a distinct form of ape intermediate between the chimpanzee and the gorilla. Schwarz (1939) rejected this claim, arguing that the specimens were in fact representatives of the lower Guinea subspecies *P.t. troglodytes.* In doing so, he recounted an earlier case, where a Dr. Vassal had presented material (skin and skulls) to the British Museum which he claimed were of an intermediate ape taxon. Schwarz (1939) examined this material and concluded that one skull was a black-faced chimpanzee *(P.t. troglodytes),* the other two being female gorillas.

Another naturalist who considered this problem was the well-known gorilla hunter Fred Merfield. He does not mention the kooloo-kamba in his 1956 book *Gorillas Were My Neighbors,* but rather discusses a gorilla-like chimpanzee known as the "*choga*" (clearly a linguistic variation of *N'tchego).* Chogas were alleged to resemble gorillas in having prominent brow ridges, some cranial cresting, black skin, small ears, and the "same smell as gorillas" (Merfield 1956:72). Merfield viewed the chogas as a rare kind of chimpanzee combining the strength of gorillas with the cunning of chimpanzees, though he felt that interbreeding between the two was not a possibility. Groves (1970) has very briefly discussed the kooloo-kamba, and claims that intermediate "pygmy gorillas" also exist, but he concluded that these forms are based on sporadic individual variation.

As noted above, this debate has most recently been rekindled by Hill (1967, 1969a). Although largely agreeing with the classification of Schwarz (1934), Hill (1969a) was struck by the persistence of local reports of the occurrence of more than one kind of chimpanzee in the general area of lower Guinea. Some of the morphological features of the kooloo-kamba outlined by Hill (1967, 1969a) are small black ears, pronounced brow ridges, an extremely prognathic face, ebony black facial color, and a "swollen" nose shaped like a gorilla's (Fig. 3). In his reviews of the genus *Pan*, Hill (1967, 1969a) erected a fourth subspecies of *Pan troglodytes*, labeling it *Pan troglodytes kooloo-kamba.* He asserted that kooloo-kamba move about singly or in small groups, and not in large troops like other chimpanzees. Both forms are said to occur side by side in the same forests, but the kooloo-kamba, according to Hill, is restricted to high level forests of the hinterland in South Cameroons, Gabon, the the former French Congo, perhaps ranging to the Zaire River (Fig. 1).

FIG. 3–(from Hill 1969a). Two chimpanzees from the Holloman Air Force Base colony, Alamagordo, New Mexico. The animal on the left was claimed by Hill to be a *Pan troglodytes kooloo-kamba,* that on the right is *P. t. troglodytes.* With permission of S. Karger Publishers, Basel.

ZOO ANIMALS

The debate surrounding the existence of the kooloo-kamba and chimpanzee-gorilla hybrids may have reached its peak in the late 1800s, involving several living apes in European zoos. These creatures supposedly presented a mix of chimpanzee and gorilla characteristics, and many authorities disagreed over which species they should be classified with, or why they varied in the ways they did. The most well-known of these apes was "Mafuca," brought from the Loango coast of Africa to the Dresden Zoological Garden in 1874 (Yerkes and Yerkes 1929). Mafuca was described by one observer as "a wild, unmanageable creature, 120 cm in height, reminding us in many respects of the gorilla" (Hartmann 1885:215). The debate over Mafuca's status generated a substantial volume of literature. She was indeed classified as a young female gorilla by several people, although many vehemently maintained that she was in fact a chimpanzee. Still others stressed the possibility that Mafuca was the offspring of a mating between a chimpanzee and a gorilla. She was pictured in Hartman (1885), Brehm (1920), and Yerkes and Yerkes (1929). Noted British anatomist Sir Arthur Keith (1899) assigned Mafuca to DuChaillu's kooloo-kamba species. The situation was confounded not only by different conclusions, but also by the fact that several investigators apparently changed their minds during the protracted debate.

A second captive pongid which engendered similar controversy was the adult female "Johanna" from the collection of Barnum and Bailey. Although the circus owners believed her to be a gorilla, Keith (1899) concluded that Johanna was a female kooloo-kamba, of relatively vicious predisposition, and characterized by the peculiar call for which that form was originally named. Keith (1899:296) also emphasized that Johanna was significant "because she represents a variety of chimpanzee which approaches the Gorilla in so many points that it is evident the characters which separate the two African anthropoids are not so well marked as many suppose." Duckworth (1898) commented that Johanna represented an unclassifiable ape, intermediate between the chimpanzee and gorilla. He placed her with Mafuca, DuChaillu's kooloo-kamba, and other intermediate specimens, as did Garner (1896). Johanna was illustrated in a color plate in Elliot (1913).

FOLK CLASSIFICATIONS

One interesting aspect of this prolonged debate, and a theme which runs throughout the century-long discussion, is that almost all claims for the existence of the kooloo-kamba or other intermediate taxa are made with supporting references to indigenous "folk taxonomies." In his 1852 letter to Geoffroy Saint-Hilaire, Franquet noted that the Africans of Gabon called the gorilla ***N'gena*** and his supposedly newly discovered ape species the ***N'tchego***. As for what they called the "common" chimpanzee, Franquet (1852:94) had to admit: "Je l'ignore, parce que je n'ai pas pensé à leur demander." [I do not know that, because I did not think to ask them.] DuChaillu also relied on African naming systems to help sort out chimpanzee variation and support his arguments for new species assignments. He claimed that the Africans of the area called *Pan troglodytes* (then *Troglodytes niger)* by the name ***Nschiego***, or the label used by Franquet (1852). To support the validity of a new species of "bald-headed" chimpanzee which he called *Troglodytes calvus*, DuChaillu (1860, 1890) noted that the Africans knew the creature by the name of ***Nschiego mbouvé***, meaning something like "another tribe of ***Nschiego***." In addition, DuChaillu (1860, 1890) stressed that the indigenous peoples knew his other newly-discovered ape species by the name of ***kooloo-kamba***, or simply ***kooloo***, on the basis of its distinctive call.

Garner (1896) also cited native naming practices as evidence for the existence of the kooloo-kamba as distinct from the ***nytigo*** (the ***N'tchego*** or ***Nschiego***). Furthermore, he described (Garner, 1896:211) another variety of ape in this area based on the folk classification:

> In the great forest regions of Esyira, the natives described to me another kind of ape, which they averred was a half-brother to the gorilla. They know the gorilla by the native name ***njina***, and the other type by the name ***nytii***. They did not confuse this with the native name ***nytigo***, which is the name of the chimpanzee, nor with the ***kulu-kamba***, all of which are known to them.

This account would give us another kind of gorilla-like chimpanzee in addition to the kooloo-kamba.

In his 1956 book, Merfield notes that in the Batouri district of central Africa, the black-faced chimpanzee (or Choga) is known by Africans as ***N'Killingi***, which means "gorilla's brother." A brief exerpt from Merfield's notes gives additional evidence; he entered the following for one specimen: "extremely hairy beast, ***N'Bodgil*** the native name of this beast, means Gorilla-like. As they were carrying it in at first glance I though it was." Raingeard (1938) argued that a form of ape intermediate between the gorilla and the chimpanzee existed in Gabon. Differentiated from both of these species by the native inhabitants, this ape was supposedly given names meaning "chimpanzee-gorilla" in the various local dialects. In Akélé, the name of this creature was the ***Koula-Nguia***, which does seem to be a combination of native names for the kooloo-kamba and the gorilla. Vassal (in Schwarz, 1939) mentioned an intermediate ape species from central Africa which had the local label ***Dediéka*** (this could be a variation of ***N'tcbego*** or ***Cboga***). In their description of African mammals, Perret and Aellen (1956:445) wrote:

> Les Boulous appellent le chimpanzé: ***wo'o***. Ils emploient le nom: ***êbôt*** pour les individus très âges qu'ils prennent pour un hybride du chimpanzé et du gorille. Le gorille, comme le chimpanzé, est encore commun dans le region de Sangmelima. Il est connu, chez les Boulous, sous le nom de: ***nji*** ou ***ngui*** [The Boulous called the chimpanzee: ***wo'o***. They use the name: ***êbôt*** for very old individuals which they take for a hybrid between the chimpanzee and the gorilla. The gorilla, like the chimpanzee, it is still known in the region of Sangmelima. It is known, among the Boulous, under the name of ***nji*** or ***ngui***.]

It is clear from this passage that Perret and Aellen (1956) believed such "hybrid" intermediates to be simply aged common chimpanzees. Further, one of the names used here for the gorilla *(nji)* would seem to be the same as Garner's (1896) supposed new intermediate variety, or the ***ntyii***.

Can we take these various indigenous labels as support for the existence of the kooloo-kamba, or a chimpanzee variety more closely approaching the gorilla? Hill (1967, 1969a) clearly did, and many of the naturalists cited above felt similarly. Others have reached a different conclusion, however. For example, Schwarz (1939: 58) cautioned his fellow naturalists:

> Le ***kooloo-kamba***, le ***dediéka*** et le ***koula-nguia***, tous sont le meme animal: Le chimpanzé à face noire de la Basse-Guinée. Sans doute les indigenes du Gabon, comme ailleurs, ne concaissent que très incomplètement les animaux de leur pays. Il faut toujours se mefier un peu de leurs rapports. [The ***kooloo-kamba***, the ***dediéka*** and the ***koula-nguia***, all are the same animal: the black-faced chimpanzee of Lower Guinea. Without doubt the native inhabitants of Gabon, as elsewhere, know only very incompletely the animals of their countries. It is always necessary to be a little distrustful of their claims.]

More complete consideration of these folk taxonomic issues would require detailed analyses of the relevent African groups and their animal taxonomies. The biggest problem here, and the fundamental flaw of the naturalists citing indigenous labels, is that no systematic attempt was made to determine the inclusive levels or hierarchies of the folk primate taxonomy. An introduction to the area of folk taxonomy and biology may be found in Raven, Berlin and Breedlove (1971), Brown (1979, 1982), Hunn (1975), Dougherty (1978), Gould (1979), and the series of articles in the August 1976 *American Ethnologist* special issue on folk biology.

It would seem that individual ape specimens have often elicited as much disagreement and debate among native African classifiers as among Western naturalists themselves. For instance, in the late 1800s a European hunter showed the skin of an ape which he believed to be the product of chimpanzee/gorilla hybridization to various native hunters, asking them what they called this animal. Most of the Africans labeled it a kooloo-kamba, but several called it the ***Nscbiego*** or ***Babu*** (chimpanzee), and a few claimed it was the *N'jina* (gorilla) (Meyer 1881). Part of the resolution of this classificatory confusion may be that Western biologists have often erroneously assumed that indigenous folk classifications closely correspond to our own Linnaean system. That such is not the case seems clear from a passage in the field notes of Fred Merfield, which I examined at the Powell-Cotton Museum in Birchington, U.K. In describing three chimpanzees from the same troop, Merfield wrote (dates unknown):

> The above beast is out of the same troop or family as nos. 449 and 450 and as the three beasts were quite different, it shakes my faith as to really black-faced chimps or chogas being a separate race. I have described the colour of the foregoing beasts as near as possible, and have also made minute enquiries from various natives to try and find out if they recognize more than one race of chimps. They do not. The different names they have for chimps, generally speaking, depends on if the beast is large or small in build, old or young, grey hair or black haired. The last six chimps I have had in I have asked the native name for each beast from three or four independent natives, but they could not agree on the names, so the various native names mean nothing.

Under another chimpanzee labeled "Choga," Merfield added: "Natives told me this was ***Pamma Guargue*** and not ***N'Bodgil***. It appears that they change the name according to size and colour of hair as already mentioned. I cannot get any clear explanation." This assessment is supported by the comments of another African visitor, R. F. Burton (1876:42), who noted two native names for chimpanzees, ***Nchigo Mpolo***, meaning "large chimpanzee," and ***Nchigo Njuê***, "white-haired chimpanzee." DuChaillu's (1860) ***Nscbiego mbouvé*** is probably a similar descriptive tag. Therefore, at least some of the variation in the indigenous labels seems to relate to description of physical differences among individual specimens. Hays (1983) notes that the Ndumba of New Guinea distinguish among certain closely related groups of animals on the basis of features such as color pattern, tail length, and overall size. We should not assume that indigenous classifiers make divisions for the same reasons or on the same bases as Western taxonomists (Dougherty 1978). Brown (1982) notes that individuals in "small-scale" societies frequently know and utilize many names for zoological and botanical groups. Additional work examining finer levels of classification of individual variations within species or subspecies categories would be of interest to the present case.

CONFUSION AND VARIATION

One of the primary reasons for the plethora of generic, specific, subspecific, and infrasubspecific designations by early naturalists undoubtedly relates to an inadequate appreciation for the range and meaning of variation among individuals and within groups. Mayr (1976) has labeled such thinking in terms of discrete and static types as "essentialism," nothing that it was a fundamental characteristic of the pre-Darwinian view of the natural world. Although we credit Darwin with the first real appreciation of individual variation and population thinking in biology, it took many years before this understanding was fully incorporated into studies of natural history and classification. Furthermore, many biologists of the 19th century interpreted morphological variation in terms of the "great chain of being" (Lovejoy 1936). Thus, one goal of studies of animal classification was to fill in the gaps between already discovered forms with groups which *a priori* must exist. The words of Paul Topinard (1876, in McKown and Kennedy 1972: 174) reflect this sentiment well:

> . . . between one type and another, sufficiently recognized for naturalists to make them the representatives of special groups, whether of order, family, genus, or species, some variation of the organ, or some bastard species, almost always comes in to establish the transition. *Natura non facit saltum.*

In regard to the foregoing remarks, it is perhaps ironic to note that indigenous classifications may have recognized and encompassed individual variation more fully than did our own early taxonomies. Finally, one additional reason for the erection of new, albeit intermediate, categories relates to "discoverer's bias" (Simons 1972), or the tendency to argue that one's own discovery represents a previously unknown form (genus, species, subspeices, etc.).

Discrepancies and contradictions in the morphological and behavioral characterizations of the purported kooloo-kambas or intermediate forms clouds the likelihood of the actual existence of such a distinct species or subspecies. To cite but several examples, while Franquet (1852), Hill (1967, 1969a), and others stressed the small size of the ears in the gorilla-like chimpanzees, DuChaillu (1860, 1890), in his original description, claimed that the ears were very large. Similarly, DuChaillu (1860, 1890), Garner (1896) and others described the face as very flat and human-like, the least prognathic of all the apes, whereas Hill (1969a) cited as a characteristic feature of *Pan troglodytes kooloo-kamba*, the "extremely prognathous face." Such variance is also found in the labels. Thus, is discussing gorilla-like chimpanzees, Merfield (1956) does not mention the kooloo-kamba, referring instead to the chogas, whereas Hill (1969a) simply lists "choga" as but one of the many synonyms for the lower Guinea subspecies of chimpanzee known to taxonomists as *Pan troglodytes troglodytes*, or the black-faced chimpanzee.

The behavioral descriptions of this purported variety are no more consistent. Hill (1967, 1969a) followed several earlier investigators (e.g. Keith 1899; Hartmann 1885) in describing the kooloo-kamba as cunning, malicious, and of savage disposition. By contrast, Garner (1896:41) referred to the kooloo-kamba as "a high order of chimpanzee, characterized by a kindly expression and confiding and affectionate to a degree beyond any other animal." And finally, recalling that the name of this ape variety is an onomatopoeic label based on its distinctive cry of "kooloo," it is of interest to note that in the 1860s when the Englishman Winwood Reade (1864:187) asked African hunters to imitate the call of the kooloo-kamba, he reported that they made a noise like "ee! – ee! – a–a–a!." In sum, although the persistence of this century-long debate is in some ways suggestive, Hill's (1967, 1969a) brief summaries camouflage a number of important inconsistences and problems in these discussions.

Further confusion in terms of the descriptions of the kooloo-kamba and other intermediate gorilla-like chimpanzees is raised when we consider that Mafuca, the ape from Dresden described above, might have been a bonobo or pygmy chimpanzee *(Pan paniscus)* (Gijzen 1975). The small ears, coal-black face, and nasal region of some bobobos do indeed recall the general appearance of gorillas. Yerkes and Yerkes (1929) made this observation and Susman (1980) has more recently noted and illustrated this similarity. Jungers and Susman (in press) argue that pygmy chimpanzees are relatively more robust and "stocky" than at least the eastern variety of common chimpanzees *(P. t. schweinfurthii)*, and thus more closely resemble gorillas. The geographical range of the bonobo chimpanzee does not coincide with the areas from which other gorilla-like chimpanzees and the kooloo-kambas have been described (Fig. 1), although Urbain and Rode (1940) claimed that their specimen of *Pan paniscus* came from the northern (or right) side of the Zaire River. Reynolds (1967) also discusses a possible extension of the present range of *Pan paniscus*. Further, Nishida (1972) gives a second-hand report of local claims that *two* kinds of chimpanzees co-exist in the Lac Tumba region of Zaire, south of the Zaire River. To add to the potential confusion, Freckhop (1935:11) compared the cry of a captive bonobo to that of the kooloo-kamba, although the bonobo's cry is usually given as a high-pitched "hi! hi! hi!" by other observers (e.g. Hill 1969a). Freckhop (1935) also noted the curious fact that to the southwest of Lodja (in the range of *Pan paniscus)*, one finds the locale "Tsheko," recalling the indigenous name for the western subspecies of common chimpanzee *(P. t. troglodytes)*.

As if the confusion surrounding the existence of gorilla-like chimpanzees were not enough, several reports of "pygmy gorillas" have been made through the years (e.g. Elliot 1913; Freckhop 1944; Groves 1970), giving us potential chimpanzee-like gorillas also. These reports have never been confirmed, and the skulls of the intermediate creatures have turned out to be either large male chimpanzees or small female gorillas (Groves 1970).

An additional consideration is that Hill's (1967, 1969a) designation of the kooloo-kamba as a subspecies of *Pan troglodytes* would appear to violate the modern taxonomic understanding of the subspecies (Mayr, 1969), which requires such groups to be geographically distinct. For example, Hill (1967:53) notes of *P. t. troglodytes* and *P. t. kooloo-kamba* that: "Both forms are said to occur side by side in the same forests, but the koolokamba is restricted to the high level forests of the hinterland in South Cameroons, Gaboon and the former French Congo." Furthermore, Hill's (1967, 1969a) assessment of the morphological criteria distinguishing the various subspecies of *Pan troglodytes* has been criticized by Reynolds and Luscombe (1971). A comparison of the subspecific status assigned by Hill to live *P. troglodytes* in the chimpanzee colony at the Holloman Air Force Base (New Mexico) with independent records indicating their country of origin yields "a very poor correlation" (C. E. Graham, personal communication). The two live animals at Holloman AFB assigned to *P. t. kooloo-kamba* by Hill are of unknown origin.

CONCLUSIONS

We can draw several conclusions from this interesting and protracted debate over the existence of the kooloo-kamba chimpanzee and other apes purported to be hybrids or intermediate between the gorillas and chimpanzees. One is that a poor knowledge of indigenous languages, a failure to adequately determine hierarchical levels of inclusivity for folk taxonomies of the apes, an inadequate appreciation of individual variation, and a desire to discover previously undescribed forms between known taxa all contributed to the confusion surrounding the enigmatic kooloo-kamba. Furthermore, early naturalists and scientists tacitly assumed that indigenous labels reflected subspecific or specific designations, when they were frequently intended to signify individual variants. The history of the classification of the kooloo-kamba, by itself, may seem esoteric at best. However, it provides an example of what probably occurred in the taxonomic history of most non-European animal groups, and thus offers insights into a more general phenomenon in the process of classification.

But the very persistence of this debate over the existence of the kooloo-kamba is also significant and revealing. Purported kooloo-kambas and other individuals claimed to be intermediate between chimpanzees and gorillas have generally turned out to be either large male chimpanzees or small female gorillas, and this fact leads us to what I consider the most important implication of this debate. The disagreement, confusion, variation, and use of intermediate or hybrid categories in both Western and indigenous classifications reflects an important biologic reality, i.e., gorillas and chimpanzees are very closely related animals with patterns of morphological development which coincide and overlap. Recent genetic investigations in the great apes have demonstrated this similarity (e.g. Bruce and Ayala 1979, Templeton 1983). This congruence is so great that the production of viable hybrids remains a real possibility, although I emphasize that this has never been attempted in captivity nor demonstrated in the wild. Chimpanzee and gorilla ranges overlap in lowland western Africa, but Jones and Sabater Pi (1971) provide evidence of ecological separation between the genera in one such area of sympatry.

On the morphological level, early workers such as Keith (1899) and Yerkes and Yerkes (1929) argued that chimpanzees and gorillas were quite similar. More recently, I have shown that patterns of ontogenetic development of the skull and postcranium are very similar in chimpanzees and gorillas, many of the shape differences between adults of these species being the result of the ultimate size differences, or the point of termination of the similar growth patterns (Shea 1981, 1983, in press). This is probably why it is large and robust male chimpanzees (or small female gorillas) which have been labeled kooloo-kambas or hybrid forms. Frechkop and Marit (1968) note the appearance of "pseudo-gorilla-like" features, such as cranial crests and a general robusticity of the masticatory appartus, in certain specimens of male chimpanzees (which, by the way, originate from the southeast rather than the southwest portion of the range of *P. troglodytes).*

Although there clearly are qualitative morphological differences between chimpanzees and gorillas, these findings help clarify some of the confusion and debate over patterns of variation and intermediate varities. Indigenous folk taxonomies capture and reflect the same morphological overlap and similarity between chimpanzees and gorillas by the use of such "hedging" (Lakoff 1973) labels as "gorilla-like," "chimpanzee-gorilla," "gorilla's brother," and so forth when describing and classifying individual chimpanzees. Our own classifications offer the kooloo-kamba, the choga, and other intermediate varieties, as well as the varying opinions of the long series of primatologists and naturalists discussed here. Although the possibility of the existence of *Pan troglodytes kooloo-kamba* must be acknowledged, the real lesson of the debate over the kooloo-kamba relates to our attempts to deal with the continuities and discontinuties of the natural world in our classifications.

ACKNOWLEDGEMENTS

I would like to thank Elizabeth Mertz and Naomi Quinn for steering me toward the literature on folk classifications. I also thank Cecil Brown for reading and commenting on an earlier draft of this paper. The comments of Will Van Asdall and two anonymous reviewers significantly improved portions of this paper, and these suggestions are greatly appreciated.

LITERATURE CITED

ALLEN, G. M. 1939. A check list of African mammals. Bull. Mus. Comp. Zool. Harvard 83:1-763.

ALLEN, J. A. 1925. Primates collected by the American Museum Congo Expedition. Bull. Amer. Mus. Nat. Hist. 47:283-499.

BREHM, A. 1920. Tierleben, Saugetier 4. Bibliographiches Institut, Leipzig.

BROWN, CECIL H. 1979. Folk zoological life-forms: their universality and growth. Amer. Anthropol. 81:791-816.

______. 1982. Folk zoological life-forms and linguistic marking. J. Ethnobiol. 2:95-112.

BRUCE, E. J., and F. J. AYALA. 1979. Phylogenetic relationships between man and the apes: electrophoretic evidence. Evolution 33:1040-1056.

BURTON, R. F. 1876. Two trips to gorilla land and the cataracts of the Congo, vols. I and II. Sampson, Low, Maiston, and Searle, London. Reprinted by Johnson Reprint Corporation, 1967.

COOLIDGE, HAROLD J., Jr. 1929. A revision of the genus *Gorilla*. Mem. Mus. Comp. Zool. Harvard 5:291-383.

DOUGHERTY, J. W. D. 1978. Salience and relativity in classification. Amer. Ethnol. 5:66-80.

DUCHAILLU, PAUL B. 1860. Descriptions of five new species of mammals discovered in Western equatorial Africa. Proc. Boston Soc. Nat. Hist. 7:296-304, 358-367.

______. 1890. Adventures in the Great Forest of Equatorial Africa and the Country of the Dwarfs. Abridged edition. John Murray, London.

DUCKWORTH, W. L. H. 1898. Note on an anthropoid ape. Proc. Zool. Soc. Lond. 20:989-994.

______. 1899. Further note on specific differences in the anthropoid apes. Proc. Zool. Soc. Lond. 21:312-314.

LITERATURE CITED (continued)

DUVERNOY, G. L. 1855. Des caractéres anatomiques des grands signes pseudanthropomorphes. Arch. Mus. Hist. Nat. Paris 8:1-248.

ELLIOTT, D. G. 1913. Review of the Primates. Amer. Mus. Nat. Hist. Monogr. no. 1, New York.

FRANQUET, E. 1852. Sur le Gabon et sur les diverses espèces de singes pseudo-anthropomorphes d'origine africaine. Arch. Mus. Nat. Hist. Paris 10:91-97.

FRECKHOP, SERGE. 1935. A propos du chimpanzé de la rive gauche du Congo. Bull. Mus. Hist. Nat. Belgique 11:1-41.

. 1943. Mammiféres. Explor. Parc. Natn. Albert Miss. S. Freckhop. no. 1:1-186.

FRECHKOP, SERGE and C. MARIT. 1968. A propos de certains caractéres ostélogiques recontrés chez des chimpanzés originaries du Maniéma. Bull. Soc. Roy. Belge Anthrop. Préhist. 79:31-40.

GARNER, RALPH L. 1896. Gorillas and Chimpanzees. Osgood, London.

GEOFFROY SAINT-HILAIRE, M. I. 1857. Description des mammiféres. Arch. Mus. Hist. Nat. Paris 10:1-90.

GIJZEN, A. 1975. Studbook of *Pan paniscus*. Acta Zool. Path. 61:119-164.

GOULD, STEPHEN J. 1979. A quahog is a quahog. Nat. Hist. 88(7):18-29.

GROVES, COLIN P. 1970. Gorillas. Weidenfield and Nicolson, London.

HARTMANN, ROBERT. 1885. Anthropoid apes. Keegan Paul, Trench and Co., London.

HAYS, TERRENCE E. 1983. Ndumba folk biology and general principles of ethnobiological classification and nomenclature. Amer. Anthropol. 85:592-611.

HILL, W. C. O. 1967. The taxonomy of the genus *Pan*. Pp. 47-54, *in* Neue Ergebnisse der Primatologie, (D. Starck, R. Schneider, and H. Kuhn, eds.) Fisher, Stuttgart.

———. 1969a. The nomenclature, taxonomy, and distribution of chimpanzees. Pp. 22-43, *in* The Chimpanzee, vol. 1. (G. H. Bourne, ed.). Karger, Basel.

———. 1969b. The discovery of the chimpanzee. Pp. 1-21, *in* The chimpanzee, vol. 1. (G. H. Bourne, ed.). Karger, Basel.

HUNN, EUGENE. 1975. A measure of the degree of correspondence of folk to scientific biological classification. Amer. Ethnol. 2:309-327.

HUXLEY, THOMAS H. 1863. Evidence as to man's place in nature. Williams and Norgate, London.

JONES, C. and J. SABATER PI. 1971. Comparative ecology of *Gorilla gorilla* (Savage and Wyman) and *Pan troglodytes* (Blumenbach) in Rio Muni, West Africa. Bibliotheca Primatol. 13. Karger, Basel.

JUNGERS, WILLIAM L., and RANDALL L. SUSMAN. In press. Body size and skeletal allometry in African apes. *In* The Pygmy Chimpanzee: Evolutionary Morphology and Behavior, R. L. Susman (ed.). Plenum, New York.

KEITH, ARTHUR. 1899. One the chimpanzees and their relationship to the gorilla. Proc. Zool. Soc. Lond. 21:296-312.

KOPPENFELS, HUGO von. 1881. Late explorations in the Gabon. Amer. Nat. 15:447-453.

———. 1887. Meine Jagden auf Gorillas. Gartenlaube, Leipzig.

LAKOFF, GEORGE. 1973. Hedges: A study of meaning criteria and the logic of fuzzy concepts. J. Phil. Logic 2:458-508.

LOVEJOY, ARTHUR O. 1936. The great chain of being. Harvard University Press, Cambridge, Massachusetts.

MATSCHIE, PAUL. 1904. Einige Bemerkungen"uberdie Schimpansen. Sb. Naturf. Fr., pp. 54-69.

———. 1919. Neue Ergebnisse der Schimpansenforschung. Z. Ethnol. 51:62-82.

MAYR, ERNST. 1969. Principles of systematic zoology. McGraw Hill, New York.

———. 1976. Evolution and the diversity of life. Harvard University Press, Cambridge, Massachusetts.

MERFIELD, FRED G. 1956. Gorillas were my neighbors. Longmans, Green and Co., London.

MEYER, A. B. 1881. Ein angeblicher Bastard zwischen Gorilla und Chimpanse. Zool. Gart. Frankfurt 22:231-236.

NISHIDA, T. 1972. Preliminary information on the pygmy chimpanzees (*Pan paniscus*) of the Congo Basin. Primates 13:415-425.

PERRET, J. L., and V. AELLEN. 1956. Mammiféres du Cameroun de la collection J. L. Perret. Rev. Suisse Zool. 63:395-450.

LITERATURE CITED (continued)

RAINGEARD, D. 1938. Note sure un anthropoide Africain: le koula-nguia. Mammalia 2:81-83.

RAVEN, PAUL H., BRENT BERLIN, and DENNIS E. BREEDLOVE. 1971. The origins of taxonomy. Science 174:1210-1213.

READE, WINWOOD W. 1864. Savage Africa. Harper and Bros., New York.

REYNOLDS, VERNON. 1967. On the identity of the ape described by Tulp 1641. Folia primatol. 5:80-87.

REYNOLDS, VERNON and G. LUSCOMBE. 1971. On the existence of currently described subspecies in the chimpanzee *(Pan troglodytes)*. Folia primatol. 14:129-138.

ROTHSCHILD, WALTER. 1904. Notes on anthropoid apes. Proc. Zool. Soc. Lond. 2:413-440.

______. 1906. Further notes on anthropoid apes. Proc. Zool. Soc. Lond. 4:465-468.

SCHWARZ, ERNST. 1934. On the local races of the chimpanzee. Ann. Mag. Nat. Hist. 1:576-583.

______. 1939. A propos du Koula-nguia. Mammalia 3:57-58.

SHEA, BRIAN T. 1981. Relative growth of the limbs and trunk in the African apes. Amer. J. Phys. Anthropol. 56:179-202.

______. 1983. Size and diet in the evolution of African ape craniodental form. Folia primatol. 40:32-68.

______. In press. Ontogenetic allometry and scaling: a discussion based on the growth and form of the skull in African apes. *In* Size and scaling in primate biology (William L. Jungers, ed.). Plenum, New York.

SHORT, R. V. 1980. The great apes of Africa. J. Reprod. Fert., Suppl. 28:3-11.

SIMONS, ELWYN L. 1982. Primate evolution. MacMillan, New York.

STILES, C. W., and M. B. ORLEMAN. 1927. The nomenclature for man, the chimpanzee, the orangutan, and the Barbary ape. Hygienic Lab. Bull. 145:1-66. US Public Health Service, Washington DC.

SUSMAN, RANDALL L. 1980. Acrobatic pygmy chimpanzees. Nat. Hist. 89:32-39.

TEMPLETON, ALAN R. 1983. Phylogenetic inference from restriction endonuclease cleavage site maps with particular reference to the evolution of humans and the apes. Evolution 37:221-244.

TOPINARD, PAUL. 1876. The origin of man. Pp. 166-181, *in* Climbing man's family tree (T. D. McCown and K.A.R. Kennedy, eds.). Prentice-Hall, Englewood Cliffs, New Jersey.

URBAIN, A., and P. RODE. 1940. Un chimpanzé pygmée *(Pan satyrus paniscus* Schwarz) au Parc zoologique du Bois de Vincennes. Mammalia 4:10-12.

WENDT, HERBERT. 1959. Out of Noah's Ark. Translated from the German by M. Bullock. Houghton Mifflin, Boston.

YERKES, R. M., and A. W. YERKES. 1929. The great apes: a study of anthropoid life. Yale University Press, New Haven, Connecticut.

Book Review

Medicinal Plants of the Bible. James A. Duke, with illustrations by Peggy-Ann K. Duke. Buffalo and New York: Trado-Medic Books/Conch Magazine Ltd., 1983, 229 pp, 138 illustrations, indices, bibliography.

Throughout human history, herbalists have played a critical role in helping relieve pain from injuries, in reducing the severity of symptoms of diseases, and in controlling certain ailments. Today, in three quarters of the world's rural population, traditional herbal practitioners continue to handle the bulk of human medical problems. In the past decade, the World Health Organization and other agencies have recognized that the skyrocketing costs of providing industrial pharmaceuticals and conventionally trained physicians will likely prohibit Western medicine from reaching all of the world's burgeoning population. Therefore, a significant investment in cooperating with traditional herbalists to ascertain suitable dosages and preparations of medicinal herbs has already been made by Mexican and Chinese scientists.

Yet perhaps it remains easier for Western scientists to show appreciation for Oriental or Amerindian-derived herbal traditions than to evaluate the Mediterranean folk medical science upon which their own heritage is based. In this intriguing compendium, Dr. James Duck directs us back toward the herbal traditions long-associated with the Holy Lands of the Middle East. The plants and lore he presents have spread with Judeo-Christian religions to many parts of the planet, to the extent that ethnobotanists working on other continents will be surprised at how many of these species and how much of this lore are immediately "familiar."

For each of 142 taxa, the following data are given: the Latin binomial and taxonomic authority; common names in modern and Biblical times; Biblical verses which refer to the plants (though not to specific medicinal uses); a narrative text on the historical importance of the plant within various cultures; the presumed therapeutic or prophylactic uses of the plants as attributed by herbalists; and a summary of the physiologically active chemical compounds that have been isolated from the plant and empirically investigated. The latter two data sets often dovetail, so that anyone with a modest amount of scientific training can begin to speculate which compounds may be responsible for which effects.

Duke's contribution would be considerable if it was merely confined to this excellent compilation of hard-to-encounter pharmacological data. Yet his writing is lucid, his references to ethnographic (especially Lebanese) and ethnohistoric herb uses are rich, and his interpretations are cautious. His personal enthusiasm for the utility of these plants is not evangelistic: "understand that I make no claim for these medical herbs or these uses! But I personally believe in and use many of them," and "Do not view this book as a prescription . . . it is merely a bibliographic compilation."

Between the careful illustrations by Peggy Ann Duke and the seasoned interpretations of Jim Duke, this book does become more than a bibliographic compilation. It is a field guide to medicinal plants commonly found in Mediterranean-climate gardens. It is a reassurance that plants used by the ancients continue to be used by Middle Eastern peasants today. It is a charming statement by a sensitive, skilled scientist who respects the wisdom of the Bible nearly as much as he does the wisdom of the forest. And lastly, it will encourage many ethnobotanists who are used to studying folk medicinal traditions of other cultures to reflect on the derivations of the Indo-European traditions from which their own heritage may be derived.

GPN

J. Ethnobiol. 4(1): 15-28 May 1984

INTENTIONAL BURNING OF DUNG AS FUEL: A MECHANISM FOR THE INCORPORATION OF CHARRED SEEDS INTO THE ARCHEOLOGICAL RECORD

NAOMI F. MILLER
Department of Anthropology
Washington University
St. Louis, MO 63130

TRISTINE LEE SMART
Museum of Anthropology
The University of Michigan
Ann Arbor, MI 48109

ABSTRACT.—An important concern of paleoethnobotanists is accounting for the presence and charring of seeds recovered archeologically. The possibility that seeds can be brought to a site incorporated in animal dung and charred when that dung is burned as fuel is considered. Researchers have shown that animal dung can contain seeds. Ethnoarcheological data from the rural village of Malyan, Iran demonstrate that seeds can be charred when dung is burned as fuel and can be recovered from deposits analogous to those commonly encountered archeologically. A description of the residue from burning dung, based on an examination of modern samples from Black Mesa, Arizona, is provided. Four conditions for determining whether the use of dung fuel might account for the presence of a charred seed assemblage are presented. Finally, two specific archeological examples are discussed in which this interpretation seems plausible for some portions of the charred seed assemblage: the archeological site of Malyan, a third millennium B.C. urban center in southern Iran, and the Tierra Blanca site, a Late Prehistoric habitation site in the Texas panhandle.

INTRODUCTION

Over the last two decades paleoethnobotanists have been thinking a great deal about how seeds are brought to a site and become incorporated into the archeological record. While it has been recognized that both modern and prehistoric (or ancient) seeds can be recovered from an archeological site, only the latter will be considered in the present study (see Keepax 1977 and Minnis 1981 for a detailed discussion of modern seed contamination). Four types of processes have been considered through which seeds could have been brought to a site in the past: (1) prehistoric seed rain (Minnis 1981:145), which involves the natural dispersal of seeds into the site area (and is not a cultural process); (2) direct resource utilization (Minnis 1981:145), in which the seed itself is utilized; (3) indirect resource utilization (Minnis 1981:145), in which seeds are brought to the site as a by-product of the use of another part of the plant for some cultural purpose; and (4) incidental inclusion with utilized resources, in which seeds are brought to the site incorporated in a resource totally distinct from that seed or plant. For example, weed seeds may be brought to a site mixed with harvested seeds and later removed during food processing (Dennell 1972, 1974, 1976, 1978; Monk and Fasham 1980; Hillman 1981). These weed seeds are brought to the site as a by-product of cultural activities.

Except in certain unusual environments, such as dry caves or waterlogged deposits, seeds must be charred to be preserved archeologically (see Minnis 1981 for a discussion of the improbability of the preservation of uncharred seeds). Three mechanisms for the charring of seeds and other plant macroremains have been suggested (Hubbard 1976:262; Minnis 1981:145; Miller 1982:136-140): (1) the catastrophic burning of a site or a portion of a site; (2) accidental burning of the plant material itself; and (3) intentional burning of the plant material primarily through use as fuel, waste disposal or in rituals.

Obviously, not all seeds brought to a site have an equal probability of being charred.

The density of a seed affects the likelihood of its becoming charred instead of burning to ash (Munson et al. 1971:427). In addition, plant processing and other cultural activities that involve fire or that occur near a fire are more likely to lead to accidental burning of seeds than activities carried out away from fire (Monk and Fasham 1980:325-326; Minnis 1981:149; Miller 1982:135-138).

In this paper we would like to discuss a mechanism for bringing seeds to a site and charring them that has not been widely considered in paleoethnobotanical analyses. We suggest that seeds can be brought to a site incorporated in animal dung and become charred when that dung is intentionally burned as fuel. We believe this process can account for the composition of certain charred seed assemblages recovered archeologically.

We will begin with a brief discussion of ethnographic evidence for the use of dung as fuel. We will then demonstrate that burning dung as fuel can result in the charring and deposition of seeds. Evidence will be presented which shows that seeds can be incorporated in animal dung. Ethnoarcheological data will be provided which demonstrate that seeds are charred through intentional burning of dung as fuel and can be recovered from deposits analogous to those commonly encountered archeologically. A description of the residue from fires using dung fuel will be provided, based on the analysis of modern burned dung samples. We will then suggest criteria for evaluating whether it is possible that an archeological seed assemblage could reflect the intentional burning of dung as fuel. Finally, we will briefly discuss the paleoethnobotanical data from a third millenium B.C. urban center in Iran and a small Late Prehistorical habitation site in the Texas panhandle for which this interpretation is plausible.

THE USE OF DUNG AS FUEL

The use of animal dung as a source of fuel is a widespread practice in areas where other fuels are in short supply or unaffordable. Ethnographic and travelers' accounts report the use of dung fuel for domestic purposes in much of Africa and Asia, and in parts of South America (e.g. Becker 1979:35, 37, 97; Hill 1972:372; Miller 1982:92; Lewis 1958:40; Ekvall 1968:50-51; Teichman 1921:8; Winterhalder et al. 1974). Dung fuel is also used in pottery manufacture in southern Asia and the American Southwest (Saraswati and Behura 1966:105; Rye and Evans 1976:41; LeFree 1975:56, 63). These areas have arid, semi-arid, or alpine environments where wood for fuel is either naturally scarce or severely depleted due to deforestation. Older ethnographic and ethnohistoric accounts document the use of dung as fuel in the past not only in some of these areas, but also on the Plains in the American West (e.g. LeBruyn 1737:228; Cunningham 1854: 219, 222; Vázquez de Espinosa 1948 [1629] :456; Hornaday, cited in Roe 1970:605).

Large herbivores commonly provide the dung that is used as fuel. In the Old World, cattle *(Bos taurus)* and sheep *(Ovis aries)* are the primary sources of dung used for this purpose. Yak *(Poephagus grunniens)* dung is also important where locally available (MacDonald 1929:20). The use of dung from goats *(Capra hircus)*, camels *(Camelus)*, horses and donkeys *(Equus)*, and the Asiatic wild ass *(Equus heminous)* for fuel has also been reported in the literature, but these do not appear to be commonly used unless other types of dung are unavailable (e.g. Lhote 1944:85; Lattimore 1941:232; Kawaguchi 1909:91). In the New World, camelid *(Lama)* and bison *(Bison bison)* dung traditionally were used for fuel in South and North America, respectively. However, cattle, sheep, and horse dung are also used in these areas today (see ref. above).

EVIDENCE FOR THE PRESENCE OF SEEDS IN DUNG

A considerable amount of research has been conducted over the last 50 years to determine whether seeds can pass through an animal's digestive tract (Atkeson et al.

1934; Harmon and Keim 1934; Burton and Andrews 1948; Piggin 1978; Takabayashi et al. 1979; Schröder and Baart 1982). While the primary goal of this work was to determine whether animal dung could be a vector for the dispersal of field weeds, the results are directly relevant to our discussion. This research focused primarily on cattle and sheep, but some work has also been done with chickens *(Gallus domesticus)*, hogs *(Sus scrofa)*, and horses (Harmon and Keim 1934). In these experiments, test animals were either fed seeds from grasses (Gramineae) and/or forbs directly, or placed in pastures with plants that were in seed.

Seeds were present in nearly all the dung samples from the mammals tested in these experiments. However, the numbers of seeds recovered varied from one species of seed to another and from one test animal to another (both between and within animal species). The amount of time that had elapsed since the ingestion of the seeds also affected the number of seeds recovered. Interestingly, some of the dung samples in these experiments contained hundreds of seeds, and in one experiment seeds were found to be present in cattle dung for at least 10 days after they were ingested (Burton and Andrews 1948:98).

The results of this research clearly demonstrate that animal dung can contain seeds when they are part of the animal's diet. However, it must be remembered that the presence and quantity of seeds in the diet of herbivores will vary depending on the seasonality of fruiting of forage/browse plants and, in the case of domesticated animals, the nature of animal fodder. At certain times of the year seeds may be absent or very rare in the animal's diet and, therefore, in the animal's dung.

DUNG FUEL AS A SOURCE OF CHARRED SEEDS

In order to study the mechanisms through which seeds become incorporated into the archeological record, Miller examined four samples of modern debris from the rural village of Malyan in southwestern Iran that were analogous to deposits commonly encountered archeologicially. These included a prepared hearth, two samples from a midden and a fire pit.

The first sample was taken in the village of Malyan from a mud-plastered hearth located in the open air on the second story of a residential compound, above animal stalls occupying the ground level. The hearth was cleaned daily by the residents. The previous evening, a fire fueled with small pieces of wood and dung cakes of cattle dung and straw had been built in this hearth in order to cook rice. The hearth sample contained wood charcoal identified as willow or poplar *(Salix/Populus)*, probably from a planted grove of willow and poplar trees near Malyan that is owned by the family. However, most of the carbonized material from the hearth was dung. Three charred seeds were found embedded in this dung and 67 additional charred seeds were recovered in the sample (Table 1).

It is likely that these additional seeds also came from the dung for several reasons. At least one of the identified seed types, dock *(Rumex)*, is a wild fodder plant that is eaten by cattle and does not grow in grain fields. Other seeds are from weedy plants that are suitable for fodder and have no known use in this area today. While these could have grown in grain fields, it was not the household practice to dispose of the grain-cleaning residue in the hearth. In addition, there are few natural sources of seeds which are likely to accidently blow into a hearth on the second story within a walled compound in a Middle Eastern village. Herbivores housed in the village compounds will eat all the vegetation in their reach long before the plants have had a chance to go to seed.

Two samples were obtained from a midden area just outside the village wall. The first was taken from an ash deposit presumed to be hearth sweeping debris, and is analogous to an archeological ash lens. The sample contained charcoal of at least three woods.

Two of them, almond *(Amygdalus)* and oak *(Quercus)*, come from the mountains about 10 km north of the village. However, the sample was predominately burned dung. Twenty seeds were found embedded in burned sheep/goat dung including 16 seeds of *Astragalus*, a leguminous fodder plant (Table 1). Most of the other seeds recovered were from weedy plants; of 764 charred seeds, only 16 are from cultigens.

The second midden sample was collected from an area of uncarbonized material located just outside the village wall. Although actual dumping of the material was not observed, the proximity of the midden to residential areas as well as the nature of the deposit suggest that the sample represents household debris and courtyard sweepings. This deposit is most analogous to ordinary trashy fill from an archeological site. The sample contained virtually no carbonized material, and straw and unburned dung accounted for most of the volume. There were no charred seeds. Of the approximately 750 uncharred seeds, 1 was embedded in dung and fewer than 25 were from cultigens (Table 1). The noncultigens were weedy plants whose seeds are not collected by the villagers. They are used as fodder and occur as field weeds.

A fourth sample was taken from a fire pit located away from the village in the oak forest. It was a subterranean feature, 1 to 1.5 m in diameter and less than 0.5 m deep, which could have been used for a shepherd's or nomad's fire or in the manufacture of charcoal by a villager. Unlike the village hearths and courtyards, this pit was totally open to the elements. Nonetheless, it contained primarily oak charcoal and a small amount (ca. 5% by weight) of burned dung. There were no stray seeds either charred or uncharred in the sample (Table 1).

The analysis of the prepared hearth and hearth sweeping samples from Malyan demonstrates that seeds can be brought to a modern village site in dung and charred when that dung is used as fuel. This was also shown in the recent analysis of the contents of an outdoor, "burgul" fireplace from the Syrian village of Tell Hammam et Turkman (Bottema in press). The Malyan hearth and hearth sweeping samples also indicate that seeds from dung can be recovered either incorporated in burned dung or as stray charred seeds within a sample. The contents of the sample from the fire pit demonstrate that burned dung does not always leave a residue of charred seeds. All of these samples provide information regarding the types of archeological deposits which might contain charred seeds that are remnants of dung burned as fuel.

DESCRIPTION OF BURNED DUNG

When dung is burned as fuel it produces two end products, fragments of burned dung and ash. A burned dung fragment is an amorphous mass of charred stems oriented in various directions within a friable matrix of fine grained, charred material. The relative proportions of charred stems and matrix can vary considerably. While dung fragments

TABLE 1.–*Seeds Recovered in Modern Refuse Samples from Malyan.*

	Prepared Hearth	Hearth Sweepings	Household Debris	Fire Pit
Refuse Sample Wt. Examined	87 g	ca. 358 g	ca. 628 g	18 g
Seeds– Cultigens Total Count	1 (charred)	16 (charred)	22 (uncharred)	0
Taxa	*Vicia ervilia*	*Hordeum distichum* *Triticum*	*Citrullus* *Cucumis* *Hordeum distichum* *Triticum* *Vitis vinifera*	

TABLE 1.—*Seeds Recovered in Modern Refuse Samples from Malyan.* (Continued)

	Prepared Hearth	Hearth Sweepings	Household Debris	Fire Pit
Seeds– Weedy				
Total Count	69 (charred)	748 (charred)	ca. 721 (uncharred)	0
Taxa	*Astragalus*	cf. *Adonis*	*Adonis*	
	Compositae	*Astragalus*[1]	*Ajuga*	
	Cruciferae[2]	Caryophyllaceae	*Amaranthus*	
	Gramineae	*Chenopodium*[3]	*Astragalus*[4]	
	Leguminosae[3]	Compositae	*Bromus*	
	Lolium	Cruciferae	Caryophyllaceae	
	Malvaceae	*Galium*	*Centaurea*	
	Papaver[3]	*Glycyrrhiza glabra*[5]	*Cephalaria*	
	Rumex[2]	Gramineae	*Chenopodium*	
	Silene	*Heliotropium*[6]	Compositae	
	Unknown (Count=5)	*Hordeum glaucum*[7]	*Convolvulus*	
	Unidentifiable[3] (Count=18)	Labiatae	Cruciferae	
		cf. *Lathyrus*	*Cynodon dactylon*[8]	
		Leguminosae[3]	*Digitaria*[9]	
		Malvaceae	Fumaria	
		Medicago	*Galium*	
		Physalis	Gramineae	
		Plantago	*Hordeum glaucum*	
		Polygonum[2]	Labiatae	
		Rapistrum[10]	cf. *Lepidium*	
		Reseda	*Lolium*	
		Rumex	Malvaceae	
		Setaria	*Medicago*	
		Solanaceae	*Physalis*	
		Sophora	*Plantago*	
		Trifolium	?*Polypogon*[11]	
		Vicia	*Polygonum*	
		Unknown[12] (Count=90)	*Reseda*[3]	
			Rumex	
			Setaria	
			Silene	
			Solanaceae	
			Sophora	
			Umbelliferae	
			Vaccaria	

[1]Includes 16 seeds embedded in sheep/goat pellets
[2]Plus 1 uncharred seed
[3]Includes 1 seed embedded in dung
[4]Includes 4 types
[5]All in 1 pod
[6]Plus 125 uncharred seeds
[7]Plus 2 uncharred seeds
[8]Plus 3 inflorescences
[9]Plus 1 inflorescence
[10]Silique
[11]Inflorescence
[12]Includes 2 seeds embedded in sheep/goat pellets

consisting primarily of charred stems are fairly distinctive, fragments made up almost entirely of charred matrix can be difficult to identify. Sometimes larger burned dung fragments retain some of the original shape of the dung, allowing identification of the animal taxon that produced it.

In order to provide some quantitative information regarding the relative amounts of ash and burned dung fragments produced by a fire fueled with dung, two modern samples were examined by Smart. These samples came from Black Mesa, Arizona, where dung was routinely burned in large, metal food cans to produce insect-repelling smoke around the work sites of the Black Mesa Archaeological Project. Cattle, sheep, and goat dung were used together as the primary fuel for these fires, although shrubby plants such as sage *(Artemisia)* and dried grass were sometimes used as kindling. Since these fires were built to produce smoke, handfuls of dirt and pebbles were sometimes tossed onto the burning dung when it began to flame (Alison Rautman and Heather Trigg personal communication). The remnants of two of these burning episodes were analyzed.

The contents of these burned dung samples were passed through three geological sieves (4.00 mm; 0.50 mm; and 0.25 mm) and the weight and volume of each fraction was recorded (Table 2). The fraction coarser than 4.00 mm consists of fragments of burned dung, clumps of gray ash, pebbles, and trash (such as cigarette butts, paper, aluminum foil, etc.). The fraction coarser than 0.50 mm contains small burned dung fragments, charred stems and other charred plant parts, clumps of gray ash, and small pebbles. The fraction coarser than 0.25 mm contains charred stems and other charred plant parts, clumps of gray ash, and sand grains. The fraction finer than 0.25 mm consists of fine, gray ash along with small flecks of charred plant material and fine sediment. This fraction was a major component of both samples (Table 2).

Charred seeds were recovered from these two samples both as stray seeds and embedded in dung (Table 2). The stray charred seeds are somewhat difficult to interpret since shrubs and grasses may have been used as kindling in these fires. However, the presence of charred seeds embedded in burned dung provides unambiguous corroboration for our contention that dung fuel can be a source of charred seeds.

It should be noted that these samples were from fires made to produce smoke. The residue of fires made for other purposes would probably look somewhat different. In addition, the nature of the burned dung will vary somewhat depending on the diet of the animal that produced it. However, these samples can provide a general impression of the nature of the residue from burning dung.

INTERPRETATION OF ARCHEOLOGICAL SEED ASSEMBLAGES

We have demonstrated that seeds can be brought to a site incorporated in animal dung and charred when that dung is used as fuel. We suggest that the use of dung as fuel be considered as one possible interpretation of an archeological charred seed assemblage when the following conditions are met: (1) the site occurs in an environment where wood for fuel might have been scarce; (2) suitable dung-producing animals were present in the area; (3) the assemblage of charred material contains burned dung and/or seeds from plants that could have been eaten by dung-producing animals; and (4) the archeological context of the samples suggests a primary hearth deposit or secondary dumping of hearth contents. Ethnographic and/or ethnohistoric evidence for the use of dung as fuel in the area can provide supporting evidence for this interpretation.

Obviously, other possible interpretations of a charred seed assemblage could be suggested even when these four conditions are met. A careful evaluation of the archeological context of the samples, the quantities of charred seeds recovered and their distribution within the site, and the evidence (ethnographic, experimental, etc.) for possible uses of identified plant taxa must be made to determine which interpretations are most plausible for each particular archeological case.

We would now like to describe briefly two very different archeological situations in which portions of the charred seed assemblages might reflect the use of dung as fuel. Our intent is to illustrate the utility of this interpretation; detailed presentations of the paleoethnobotanical data from these sites are provided elsewhere (Miller 1981, 1982; Smart 1982).

TABLE 2.—*Modern Burned Dung Samples from Black Mesa.*

Fractions	Sample 1	Sample 2
Total sample		
Volume	775 ml	950 ml
Weight	244.5 g	429.3 g
Coarser than 4.00 mm		
Volume	125 ml	75 ml
Total Weight	18.9 g	17.2 g
Trash Weight	0.6 g	1.6 g
Pebble Weight	0.7 g	3.1 g
Charred Seeds		
Total Count	5[1]	7[1]
Taxa	*Amaranthus* Chenopodiaceae *Chenopodium* Unidentifiable (Count=2)	*Chenopodium* Unidentifiable (Count=1)
Coarser than 0.50 mm		
Volume	250 ml	200 ml
Weight	44.4 g	50.8 g
Charred Seeds		
Total Count	29+6 frags	30+4 frags[2]
Taxa	*Amaranthus* *Chenopodium* Gramineae *Portulaca* *Salsola kali* Unidentifiable[4] (Count=13+4 frags)	*Chenopodium*[3] Gramineae Unidentifiable (Count=5+1 frag)
Coarser than 0.25 mm		
Volume	75 ml	75 ml
Weight	28.0 g	31.2 g
Charred Seeds		
Total Count	1[5]	1+1 frag[6]
Taxa	Gramineae	*Chenopodium* Unidentifiable (Count=1 frag)
Finer than 0.25 mm		
Volume	325 ml	600 ml
Weight	153.2 g	330.1 g

[1]All seeds embedded in dung
[2]Sample of 13.1 g was examined for seeds
[3]Includes 1 seed embedded in dung
[4]Includes 3 seeds embedded in dung
[5]Sample of 13.3 g was examined for seeds
[6]Sample of 7.5 g was examined for seeds

CHARRED SEEDS FROM ANCIENT MALYAN

Background.—The first example comes from the archeological site of Malyan, a major urban center during the third millennium B.C., contemporary with Sumerian and Akkadian civilization in Mesopotamia (Sumner 1974; 1980). The site is located in the Kur basin, an intermontane valley in the Zagros of Iran. Today the region is largely deforested, although there is a remnant oak forest about 10 km north of the village and a degraded pistachio-almond *(Pistacia-Amygdalus)* forest about 100 km away at the southern end of the valley.

Plant remains from Malyan were analyzed by Miller (1981, 1982). Nearly 200 flotation samples were collected from a variety of deposits, including hearths, pits, room floors and trashy and non-trashy fill. The assemblage of plant materials recovered from Malyan is in many respects typical of Near Eastern sites. In general, the material was sparsely distributed. Approximately half of the samples contained less than 1.5 g of charred material per 10 liters of sediment. The deposits sampled contained an assortment of taxa and plant parts. The bulk of the material consisted of charcoal and charred seed and rachis fragments. The seeds represent a variety of taxa, cultivated and wild. The economic base was wheat *(Triticum)* and barley *(Hordeum)* agriculture; other common food plants were grape *(Vitis)*, pistachio and almond. We believe that the seeds from weedy plant types from many, if not most of the samples from this site became charred because they were incorporated in animal dung burned as fuel.

Meeting the conditions for the dung fuel interpretation.—Based on charcoal analysis, it appears that deforestation progressed during the course of the third millennium B.C. in this highland region. In particular, charcoal percentages from tree species which could have grown in the valley close to Malyan decrease, and percentages of oak, which grows on the hill slopes, increase (Miller 1981, 1982:212-216, 221-231). Textual evidence provides some corroboration for deforestation in the third millennium B.C. in this area (Hansman 1976). This suggests an ancient environment in which wood for fuel was becoming increasingly difficult to obtain.

The main Middle Eastern domesticated animals, sheep, goats and cattle, have been reported from the site by Zeder (1980). All of these animals produce dung that is suitable for use as fuel. Dung cakes and dung are commonly used as fuel in this area today since wood is scarce. These are historical references for this practice as well. For example, in the eighteenth century a traveler commented that the main highway in this region was kept clean, as animal dung was collected for fuel (LeBruyn 1737:228).

Twelve flotation samples contained burned dung. Charred weed seeds were found embedded in burned dung in six of these samples. In addition, a substantial number of the charred seeds recovered in these and other samples from the site are from plants of no known economic importance today *except* as fodder (Table 3).

All 12 samples containing burned dung had charcoal in them as well, and 10 were from trashy deposits encountered in either the site matrix or within pits (Miller 1982: 205). These kinds of deposits could represent secondary dumping of the contents of hearths. This would be consistent with an interpretation that the burned dung and charred weed seeds from fodder plants are the remnants of dung burned as fuel. Other samples from similar contexts also contain these types of charred seeds and their presence may be the result of the use of dung fuel as well.

Interpretation.—While the conditions for considering the use of dung fuel as a possible interpretation of the charred seed assemblages from ancient Malyan have been met, alternative interpretations must be considered. There is no evidence for overall site burning in the third millennium B.C. levels of the site. Therefore, charring probably occurred either accidentally or intentionally in fires set for cooking, heating, industrial processes and waste disposal.

TABLE 3.—*Weedy Seed Taxa from Ancient Malyan.*

Adonis[1]	Gramineae[1,2]
Aegilops[1]	*Hordeum*[1]
Ajuga	*Hyoscyamus*
Astragalus[1,2]	Labiatae
cf. *Atriplex*	Leguminosae[1,2,3]
Avena	*Lepidium*[1]
Boraginaceae	cf. *Lithospermum*
Bromus[1]	*Lolium*[1]
Carex[1,2,3]	Malvaceae[1]
Caryophyllaceae	*Medicago*[1]
Centaurea[1]	*Neslia*
Ceratocephalus[1]	cf. *Panicum*
Chenopodiaceae	*Phalaris*
Chenopodium	*Polygonum*[1]
Compositae	*Potentilla*[1]
Cruciferae[1,2]	*Prosopis*[1]
Cucurbitaceae	*Rumex*[1]
Cyperaceae[1]	*Setaria*[1,2]
Cyperus[1,2,3]	*Silene*[1]
cf. *Cynodon*[1]	*Solanaceae*[1,2]
cf. *Delphinium*	cf. *Trifolium*[1]
cf. *Eremopyrum*[1]	Umbelliferae[1]
Euphorbiaceae	cf. *Vaccaria*[1]
Fumaria	cf. *Valerianella*
Galium[1,2]	*Vicia* (not *ervilia)*

[1]Taxon found in sample containing burned dung
[2]Taxon found in 10% or more of the samples from the same time period
[3]Taxon found embedded in burned dung

Ethnographic data from Malyan suggest that accidental burning of the natural seed rain is unlikely in architecture similar to that found archeologically at the site. Hence, the charred seeds were probably brought to the site as the result of direct resource utilization, indirect resource utilization or incidental inclusion with utilized resources.

There are no caches of charred seeds (weeds or cultigens) from the site that would suggest intentional collection for food, medicine or other culturally defined purposes. Most of the identified weedy taxa have no known use in the modern village of Malyan except as fodder for animals, indicating that these seeds probably were not brought to the site by direct or indirect resource utilization (although the possibility that plant use was different in ancient Malyan does exist).

The likelihood that the seeds represent the residue of the burning of crop processing by-products (cf. Hillman 1981) can be discounted for these deposits since most samples have low weedy seed densities. Those with the highest weedy seed densities (greater than 100 seeds per 10 liters of sediment) have high counts of precisely those taxa that are *not* field weeds, namely *Carex* and other sedges (Cyperaceae).

The presence of burned dung (some of which contains charred seeds) from trashy deposits strongly suggests that dung was burned as fuel in ancient Malyan. It is possible that some of the charred seeds from weedy taxa were brought to the site and became charred through other processes. However, since the chances of preservation are greater when plant material is regularly and/or intentionally burned, it is likely that much of the charred seed assemblage from this site is the result of the intentional burning of dung as fuel.

The interpretation that the charred seeds from ancient Malyan originated in dung used as fuel corroborates the charcoal evidence for deforestation during the third millennium B.C. in the valley. There was a ten-fold increase in charred seeds during the course of the third millennium, as measured by absolute numbers of seeds, the number of seeds per unit volume of sediment, and the proportion by weight of seeds to charcoal (Miller 1982:209-215, 219). As wood became scarcer around the settlement, dung became an increasingly important fuel source, resulting in the deposition of greater quantities of seeds relative to charcoal.

CHARRED SEEDS FROM THE TIERRA BLANCA SITE

Background.—Our second archeological example is the Tierra Blanca site (41DF3), a Late Prehistoric site located in the panhandle area of Texas (Spielmann 1982). This is a small habitation site which apparently was occupied several times from ca. A.D. 1200-1400 to ca. A.D. 1425-1525. It is situated on a bluff above the semi-permanent Tierra Blanca creek. The modern vegetation in the area is short-grass grassland with riparian species growing along the creek. This creek-side vegetation includes a number of tree species that were planted in the area in the 1940s.

The plant remains from the site, analyzed by Smart (1982; final report in preparation), include charcoal, charred seeds and a maize *(Zea mays)* cob and cupule fragments. Fifty-four flotation samples ranging in size from 0.75 to 2 liters were taken. These samples came from a variety of contexts including hearths, roasting pits, ash dumps, structures and other deposits rich in organic material. Slightly more than half (57%) of the samples contained charred seeds. The most commonly encountered identified seeds are members of the grass family. Other identified seed types are the sedge family and weedy plant types including goosefoot *(Chenopodium)*, the knotweed family (Polygonaceae) and purslane *(Portulaca)*.

Two particularly interesting flotation samples were taken from an ashy deposit within an impermanent habitation structure consisting of a ring of boulders possibly used to anchor a skin or brush superstructure (Spielmann 1982:284). The densities of charred seeds from these two samples were much greater than those from the other samples containing whole charred seeds. These two samples had an average density of ca. 575 whole seeds per liter of sediment while the densities from the other samples ranged from 0.5 to 26.5 whole seeds per liter of sediment with an average of 4.2 whole seeds per liter. Together the two samples from this ashy deposit contained over 1800 charred small grass seeds of the *Eragrostis/Sporobolus*-type[1] and more than 50 grass seeds of other types, smaller numbers of sedge seeds, and a few seeds of the weedy plant types, goosefoot and purslane. We believe the presence of grass and sedge seeds in this deposit could be the result of the use of dung as fuel.

Meeting the conditions for the dung fuel interpretation.—The results of the analysis of palynological samples from the Tierra Blanca site suggest that the environment of the area at the time this site was occupied was similar to the modern environment (Gish 1982). In this short-grass grassland environment, obtaining sufficient wood for fuel could have been a problem.

Prehistorically, the short-grass Plains region was the home of herds of bison, which produce dung that is suitable for fuel. The aboriginal use of bison dung as fuel is documented in several Plains Indian ethnographies (e.g. Hornaday, cited in Roe 1970:605; Grinnell 1923a:53-54; Wallace and Hoebel 1952:51, 90; Opler 1941:394). In addition, a number of historical accounts of early travelers in the American West refer to the use of "buffalo chips" or "*bois de vache*" for fuel (Roe 1970:346, 605-606). Faunal remains recovered from the site demonstrate that bison were present in the site area and in fact were the primary focus of the economic activities of its inhabitants (Spielmann personal communication).

A recent study of the foods eaten by modern bison inhabiting the short-grass Plains region of Colorado demonstrates that grasses and sedge make up the bulk of their diet (Peden 1972:36-39). Seeds from both these families were found in the two flotation samples from the ashy deposit. Interestingly, the diet of these modern bison includes *Sporobolus cryptandrus* and another species from a closely related genus (following Gould 1975), *Muhlenbergia torreyi* (Peden 1972:113).

The ashy nature of this archeological deposit suggests it is the product of secondary dumping of hearth contents. This is consistent with an interpretation that the charred grass and sedge seeds from this deposit are remnants of the use of dung as fuel.

Interpretation.—Although the conditions for considering the dung fuel interpretation have been met, alternative interpretations of this seed assemblage of course are possible. Since there is no evidence for general burning of this structure, these seeds must have been charred by accidental or intentional burning of the plant material.

Accidental charring of the natural seed rain can not be ignored on a relatively open site such as Tierra Blanca. However, the recovery of large quantities of the same seed taxon in these two samples is inconsistent with this interpretation. Therefore, these *Eragrostis/Sporobolus*-type grass seeds were probably deposited at the site as the result of direct resource utilization, indirect utilization or incidental inclusion with utilized resources. The larger grass and sedge seeds may have been deposited as a result of these processes as well.

The large quantities of *Eragrostis/Sporobolus*-type grass seeds present in these two samples could indicate that the seeds themselves were used, possibly as food. The use of *Sporobolus cryptandrus* seeds as food has been documented in the ethnobotanical literature for two Plains Indian groups, the Apache and the Kiowa (Castetter and Opler 1936:48; Vestal and Schultes 1939:17). Seeds from *Muhlenbergia,* a related genus, were reportedly used as food by the Apache as well (Reagan 1929:157; Castetter and Opler 1936:48). To our knowledge there is no report of the use of *Eragrostis* seeds as food by any Plains Indian group. They were utilized by the Paiute, inhabitants of the Great Basin, who had a very different hunting/gathering subsistence strategy than the Plains Indian groups (Doebley 1984).

The nature of the archeological deposit that contained these seeds rules out the possibility that they were part of a cache that accidentally burned. If these grass seeds were collected for food they probably became charred as the result of an accident during processing. Interestingly, the fruiting structure of *Sporobolus* is such that the naked grain is "easily freed from its membranous bracts. This may make processing simpler, as heating to free the grain from its bracts is not required" (Doebley 1984:59). This would also reduce the likelihood of charring due to processing accidents. However, parching of *Sporobolus cryptandrus* seeds as part of food preparation was reported among the Kiowa (Vestal and Schultes 1939:17).

The charred grass and sedge seeds from these samples could be the by-product of other cultural activities. For example, sedges, especially *Scirpus,* were commonly used to make mats in the Plains area (Gilmore 1919:69; Grinnell 1923b:170-171). Sedge seeds might have been a by-product of the mat-making process which were accidentally or intentionally added to the fire.

There are ethnographic accounts of the use of grass to cover foods roasted in outdoor pits (Castetter and Opler 1936:29; Opler 1941:367). This practice could easily result in the charring of grass seeds. However, the archeological context of these samples suggests that this was not the case. A roasting pit adjacent to the structure in question contained only one grass seed, and a dump which was directly associated with this pit contained no charred seeds at all. Another roasting pit associated with an earlier occupation of the site contained only a few grass seeds. None of these features contained sedge seeds. In addition, since the roasting pits were located outside of the structures, and the seed-rich ashy deposit was located within a structure, it seems more likely that the ashy deposit was residue from an internal hearth rather than a roasting pit.

It is not possible to discount the interpretation that the hundreds of charred *Eragrostis/Sporobolus*-type grass seeds from these samples were collected for use as food or that the sedge seeds were brought to the site as a by-product of the use of that plant. However, we feel that the dung fuel interpretation is equally plausible and can account for the presence of both grass and sedge in the charred seed assemblage from this deposit.

CONCLUSIONS

We have demonstrated that seeds can be brought to a rural village incorporated in dung and become charred when that dung is used as fuel. We believe that dung burned as fuel can account for certain archeological seed assemblages as well. Such charred seed assemblages reflect animal dietary patterns rather than the natural seed rain, direct use of the seeds or ther plant parts of those taxa, or plant processing practices.

We enumerated four conditions for assessing whether the use of dung as fuel might account for a given charred seed assemblage and presented two very different archeological cases in which this interpretation seems plausible, an urban center from the Middle East and a small hunter/gatherer habitation site from the southern Plains. These examples demonstrate that the dung fuel interpretation is applicable even in the absence of seeds actually embedded in burned dung from a given sample. Yet no interpretation is appropriate for every site, and even in these cases alternative explanations have been considered. Paleoethnobotanical interpretation always depends on careful evaluation of the particular and unique archeological deposits and associated plant remains under consideration.

We hope that this paper has demonstrated the value of identifying additional mechanisms that can account for the presence of seeds on a site and their incorporation into the archeological record. Ultimately, the better our understanding of depositional processes becomes, the more accurate our reconstruction of past economies and environments will be.

ACKNOWLEDGEMENTS

We would like to thank Vaughn M. Bryant, Jr., Richard I. Ford, John M. O'Shea, John D. Speth, and our anonymous reviewer for their useful comments on earlier versions of this paper. We are grateful to the assistant crew chiefs and crew members of the ethnobotanical lab of the Black Mesa Archaeological Project who took our request for burned dung samples seriously. The recent excavations at ancient Malyan were directed by William Sumner under the auspices of the University Museum of the University of Pennsylvania. Excavations at the Tierra Blanca site were conducted by Katherine A. Spielmann as part of her dissertation research while she was a student at The University of Michigan.

LITERATURE CITED

ATKESON, F. W., H. W. HULBERT and T. R. WARREN. 1934. Effect of bovine digestion and of manure storage on the viability of weed seeds. J. Amer. Soc. Agron. 26: 390-397.

BECKER, PETER. 1979. Inland Tribes of Southern Africa. Granada Publ., New York.

BOTTEMA, S. In press. The composition of modern charred seed assemblages. *In* Plants and Ancient Man, Studies in Palaeoethnobotany (W. van Zeist and W. A. Casparie, eds.). A.A. Balkema, Rotterdam.

BURTON, GLENN W. and JOHN S. ANDREWS. 1948. Recovery and viability of certain southern grasses and lespedeza passed through the bovine digestive tract. J. Agric. Res. 76(3&4):95-103.

CASTETTER, EDWARD F. and MORRIS E. OPLER. 1936. The Ethnobiology of the Chiricahua and Mescalero Apache. Univ. New Mexico Bull., Biol. Ser. 4(5).

CUNNINGHAM, ALEXANDER. 1854. Ladak, Physical, Statistical and Historical. William H. Allen and Co., London.

DENNELL, ROBIN W. 1972. The interpreta-

LITERATURE CITED (continued)

tion of plant remains: Bulgaria. Pp. 149-159, *in* Papers in Economic Prehistory (E.S. Higgs, ed.). Cambridge Univ. Press, Cambridge.

__________. 1974. Botanical evidence for prehistoric crop processing activities. J. Archaeol. Sci. 1:275-284.

__________. 1976. The economic importance of plant resources represented on archaeological sites. J. Archaeol. Sci. 3:229-247.

__________. 1978. Early Farming in South Bulgaria from the VI to the III Millennia B.C. BAR Internatl. Ser. (Suppl.) No. 45, Oxford.

DOEBLEY, JOHN F. 1984. "Seeds" of wild grasses: A major food of Southwestern Indians. Econ. Bot. 38(1):52-64.

EKVALL, ROBERT B. 1968. Fields on the Hoof: Nexus of Tibetan Nomadic Pastoralism. Holt, Rinehart and Winston, New York.

GILMORE, MELVIN R. 1919. Uses of Plants by the Indians of the Missouri River Region. Gov. Printing Office, Washington.

GISH, JANNIFER W. 1982. Pollen results from the Tierra Blanca site, northwestern Texas panhandle. Appendix D *in* Inter-Societal Food Acquisition Among Egalitarian Societies: An Ecological Study of the Plains/Pueblo Interaction in the American Southwest (K.A. Spielmann). Ph.D. dissertation (Anthrop.), The Univ. of Michigan, Ann Arbor. Univ. Microfilms, Ann Arbor.

GOULD, FRANK W. 1975. The Grasses of Texas. Texas A&M Univ. Press, College Station.

GRINNELL, GEORGE B. 1923a. The Cheyenne Indians, Their History and Ways of Life, Vol. I. Yale Univ. Press, New Haven.

__________. 1923b. The Cheyenne Indians, Their History and Ways of Life, Vol. II. Yale Univ. Press, New Haven.

HANDSMAN, JOHN. 1976. Gilgamesh, Humbaba and the land of the ERIN-trees. Iraq 38:23-35.

HARMON, GEORGE W. and F. D. KEIM. 1934. The percentage and viability of weed seeds recovered in the feces of farm animals and their longevity when buried in manure. J. Amer. Soc. Agron. 26:762-767.

HILL, POLLY. 1972. Rural Hausa: A Village and a Setting. Cambridge Univ. Press, Cambridge.

HILLMAN, GORDON C. 1981. Reconstructing crop husbandry practices from charred remains of crops. Pp. 123-162, *in* Farming Practices in British Prehistory (Roger Mercer, ed.). Edingurgh Univ. Press, Edinburgh.

HUBBARD, R. N. L. B. 1976. On the strength of the evidence for prehistoric crop processing activities. J. Archaeol. Sci. 3:257-265.

KAWAGUCHI, SHRAMANA EKAI. 1909. Three Years in Tibet. Theosophist Publ. Soc., London.

KEEPAX, CAROLE. 1977. Contamination of archaeological deposits by seeds of modern origin with particular reference to the use of flotation. J. Archaeol. Sci. 4:221-229.

LATTIMORE, OWEN. 1941. Mongol Journeys. Doubleday, Doran and Co., New York.

LEBRUYN, CORNELIUS. 1737. Travels into Muscovy, Persia, and Part of the East Indies, 2 Vol. (trans. from French). Bettesworth, London.

LEFREE, BETTY. 1975. Santa Clara Pottery Today. Univ. of New Mexico Press, Albuquerque.

LEWIS, OSCAR. 1958. Village Life in Northern India. Vintage Books, New York.

LHOTE, HENRI. 1944. Les Touaregs du Hoggar (trans. for the Human Relations Area Files). Payot, Paris.

MACDONALD, DAVID. 1929. The Land of the Lama. Seeley, Service and Co., Ltd. London.

MILLER, NAOMI F. 1981. Paleoethnobotanical studies at Malyan: The use of wood as fuel. Paper, 45th Meeting Soc. Amer. Archaeol., Philadelphia, May 1, 1980.

__________. 1982. Economy and Environment of Malyan, a Third Millennium B.C. Urban Center in Southern Iran. Ph.D. dissertation (Anthrop.), The Univ. of Michigan, Ann Arbor. Univ. Microfilms, Ann Arbor.

MINNIS, PAUL E. 1981. Seeds in archaeological sites: Sources and some interpretive problems. Amer. Antiquity 46(1): 143-152.

MONK, M. A. and P. J. FASHAM. 1980. Carbonised plant remains from two Iron Age sites in central Hampshire. Proc. Prehist. Soc. 46:321-344.

MUNSON, PATRICK J., PAUL W. PARMALEE and RICHARD A. YARNELL. 1971. Subsistence ecology of Scoville, a Termi-

LITERATURE CITED (continued)

nal Middle Woodland village. Amer. Antiquity 36(4):410-431.

OPLER, MORRIS E. 1941. An Apache Life-Way: The Economic, Social and Religious Institutions of the Chiricahua Indians. Univ. of Chicago Press, Chicago.

PEDEN, DONALD G. 1972. The Trophic Relations of *Bison bison* to the Short-grass Plains. Ph.D. dissertation (Ecol.), Colorado State Univ., Fort Collins. Univ. Microfilms, Ann Arbor.

PIGGIN, C. M. 1978. Dispersal of *Echium Plantagineum* L. by sheep. Weed Res. 18:155-160.

REAGAN, ALBERT B. 1929. Plants used by the White Mountain Apache Indians of Arizona. Wisconsin Archeol. 8(3):143-161.

ROE, FRANK G. 1970. The North American Buffalo: A Critical Study of the Species in its Wild State. Univ. of Toronto Press, Toronto.

RYE, OWEN S. and CLIFFORD EVANS. 1976. Traditional Pottery Techniques of Pakistan. Smithsonian Contrib. to Anthrop. No. 21.

SARASWATI, BAIDYANATH and NEB KISHORE BEHURA. 1966. Pottery Techniques in Peasant India. Anthrop. Surv. of India, Calcutta.

SCHRÖDER, J. and E. A. D. BAART. 1982. Draagt drijfmest bij aan de verspreiding van *Echinochloa crus-galli?* Med. Fac. Landbouww. Rijksuniv. Gent 47(1):27-35.

SMART, TRISTINE LEE. 1982. Preliminary report on the plant macro-remains from the Tierra Blanca site, Deaf Smith County, Texas. Appendix E, *in* Inter-Societal Food Acquisition Among Egalitarian Societies: An Ecological Study of the Plains/Pueblo Interaction in the American Southwest (K.A. Spielmann). Ph.D. dissertation (Anthrop.), The Univ. of Michigan, Ann Arbor. Univ. Microfilms, Ann Arbor.

SPIELMANN, KATHERINE A. 1982. Inter-Societal Food Acquisition Among Egalitarian Societies: An Ecological Study of Plains/Pueblo Interaction in the American Southwest. Ph.D. dissertation (Anthrop.), The Univ. of Michigan, Ann Arbor. Univ. Microfilms, Ann Arbor.

SUMNER, WILLIAM. 1974. Excavations at Tall-i Malyan, 1971-1972. Iran 12:155-180.

__________. 1980. The Malyan project: Introduction. Paper, 45th Meeting Soc. Amer. Archaeol., Philadelphia, May 1, 1980.

TAKABAYASHI, MINORU, TETSUO KUBOTA and HAYASHI ABE. 1979. Dissemination of weed seeds through cow feces. JARQ 13(3):204-207.

TEICHMAN, ERIC. 1921. Travels of a Consular Officer in Northwest China. Cambridge Univ. Press, Cambridge.

VÁZQUEZ DE ESPINOSA, ANTONIO. 1948 [1629]. Compendio y Descripcion de las Indias Occidentales. Smithsonian Misc. Coll. Vol. 108.

VESTAL, PAUL A. and RICHARD E. SCHULTES. 1939. The Economic Botany of the Kiowa Indians as it Relates to the History of the Tribe. Bot. Mus., Cambridge.

WALLACE, ERNEST and EDWARD ADAMSON HOEBEL. 1952. The Comanches: Lords of the South Plains. Univ. of Oklahoma Press, Norman.

WINTERHALDER, BRUCE, ROBERT LARSEN and R. BROOKE THOMAS. 1974. Dung as an essential resource in a highland Peruvian community. Human Ecol. 2(2):89-104.

ZEDER, MELINDA A. 1980. Animal resource distribution and early urban development in southern Iran. Paper, 45th Meeting Soc. Amer. Archaeol., Philadelphia, May 1, 1980.

NOTES

[1]These small grass seeds are very similar in appearance to seeds of the genera *Eragrostis* and *Sporobolus*. However, due to the very large number of grass genera native to the area and limitations in the available comparative material, the possibility that these seeds are from another grass genus can not be ruled out at this time.

J. Ethnobiol. 4(1):29-43 May 1984

EVIDENCE OF WOOD-DWELLING TERMITES IN ARCHAEOLOGICAL SITES IN THE SOUTHWESTERN UNITED STATES

KAREN R. ADAMS
Department of Ecology and Evolutionary Biology
University of Arizona
Tucson, AZ 85721

ABSTRACT.–Distinctively shaped fecal pellets of wood-dwelling termites have been recovered from a number of Southwestern archaeological contexts ranging from 600-2000 years of age. Pellet presence in a site may derive from prehistoric use of termite-infested firewood, or may signal actual termite colonization in the roofs and walls of ancient dwellings. Recovery of abundant uncarbonized pellets throughout strata should alert the archaeologist to possible post-occupational site disturbance; these same uncarbonized pellets may be useful in tracing the prehistoric geographic distributions of various Southwestern termite species. Carbonized pellets shrink differentially, depending on conditions under which they burned, and cannot be used to infer termite species identification and distribution.

INTRODUCTION

Some primal termite knocked on wood
And tasted it, and found it good,
And that is why your Cousin May
Fell through the parlor floor today.
Ogden Nash (1942)

When Ogden Nash wrote about termites with tongue in cheek, he acknowledged an insect whose history and habits have undoubtedly long interfaced with those of man. There is now evidence that wood-dwelling termites have lived close to humans in the American Southwest for at least ten centuries. Termite presence in prehistory may be signaled by distinctive fecal pellets recovered from ancient soil samples.

The archaeological record commonly reveals organic items that defy careful attempts at identification; often an ethnobiologist must be content with providing a thorough morphological description to share with colleagues. Escalated attempts at identification are justified if an unknown type occurs repeatedly in deposits at a single site, or in several locations that vary in both space and time. In the Southwestern United States a decade passed between recognition of a small item originally labeled the "Tule Springs Unknown" (Bohrer 1972:22), and its identification by an entomologist as a wood-dwelling termite fecal pellet. The connecting link was provided by a sharp-eyed graduate student who realized that small items associated with termite nests in California and Utah looked just like unidentified specimens he had observed while sorting plant and insect parts from archaeological soil samples. Subsequent comparison by the author of ancient charred "Tule Springs Unknown" specimens from a number of archaeological deposits with modern wood-dwelling termite fecal pellets confirmed the identity of the ancient unknown.

THE NATURAL HISTORY OF WOOD-DWELLING TERMITES

In contrast to earth-dwelling termites that actually inhabit soil, wood-dwelling termites are entirely confined to wood, the whole colony generally living within a small section of trunk or branch (Light 1946a). These termites enter wood directly from the air during swarming, and remain there throughout the life of the colony. Wood-dwelling termites comprise two major types: the dry-wood insects that attack only sound, dead wood with a relatively low moisture content, and damp-wood termites that require moister, often decaying wood. Dry-wood termites can easily invade and live in wood located high above ground such as the wooden rafters of an adobe dwelling; they require no contact with the ground throughout colony life. In contrast, damp-wood termites may often be encountered in buried wood along water-courses or in buried stumps.

Distribution.—About forty species of termites inhabit the continental United States. Nearly all species are native, having been here for millenia before humans arrived on the continent. People, however, modify termite distribution by providing for their spread into new and unoccupied areas (Kofoid 1946a:7). Activities such as the transport of infested soil, wood, household furniture, and living plants provide a means by which termite colonies become established in regions wholly new for some species. Lines of fence posts and poles connecting cities and villages facilitate the spread of termites from one locality to another. Termites now inhabit colder northern regions, warmed by the same fossil-fuel burning furnaces that keep people warm.

Two families comprising five genera of wood-dwelling termites are known from native habitats in the Southwestern United States today (Table 1) They include species of both restricted and extensive distribution. Over half of the nine species occur below 1130m. Patterns of plant use vary widely among the termites, with some occurring in few plants, while others are found in a variety of plants in a broad range of habitats.

Food.—The food of termites is cellulose, one of the more resistant and durable products of photosynthesis. Cellulose is extremely abundant in the xylem, or conducting tissue, of woody plants. In general, sapwood is more appealing to a termite because it contains less lignin and a greater amount of useful organic compounds than heartwood; likewise, un-seasoned wood is more vulnerable to termite attack, as is wood felled in the summer (Kofoid 1946b:571). While termites exhibit preferences when offered a variety of wood types (Williams 1946:572) they will often eat whatever is available; even redwood, cedar and cypress, often touted as "termite resistant", are vulnerable. Five of the termites listed in Table 1 are known to live in six or more native plants. Others opportunistically inhabit whatever tree products humans make available to them. These records suggest that choice of host material may sometimes be as much controlled by proximity as any other factor. If adequate moisture and minimum temperature requirements are met, wood-dwelling termites might be able to survive in at least some of the woody plant species in any given region.

Most termites can break down the cellulose of their plant hosts because of a symbiotic relationship with various *Protozoa* and bacteria that live in their gut (Kofoid 1946a: 5; LaFage and Nutting 1977). Undigested residue containing from 40-60% lignin, less than 30% carbohydrates, and negligible nitrogen is eliminated (LaFage 1976:98; Lee and Wood 1971:393). Because of the relatively low moisture content of the wood they eat, wood-dwelling termites often produce compact recognizable fecal pellets (Light 1946b: 215).

Fecal Pellets.—A typical pellet of a wood-dwelling termite is a small, hard, oblong object possessing six surfaces. At the angles between the six surfaces, longitudinal ridges are often visible (Fig. 1). One end of the pellet is usually blunt, while the other may appear slightly tapered or rounded reminding one of a bullet (Fig. 2). The sides of the pellet are generally parallel to one another, but may slope to one end as in pellets of *Paraneotermes*. The sides may be flattened, slightly convex or sometimes concave. Pellet color is quite variable, apparently related to the kind of wood being eaten (Castle 1946:281). The author has seen white, tan, brown, black and mottled modern pellets. Pellet surface texture appears finely granular at 60x magnification; when cut in cross section, the interior is of a solid homogeneous texture similar to the exterior.

Length and width of modern termite pellets vary with species. Fifty randomly chosen, entire pellets of eight Southwestern wood-dwelling species were measured under

TABLE 1.—Ecological and plant-host data on wood-dwelling termites of the Southwestern United States.

Type of Termite; Family and Species	Geographical Distribution and Elevational Range	Observed Plant Hosts of Various Natural Habitats and Man-made Habitats/Structures: Desert	Riparian	Mountain	Introduced Plants or hosts provided by humans	References
Dry-Wood Termites: Family Kalotermitidae						
Incisitermes banksi[1] (Synder)	Rare and little known termite of Sonoran desert scrub in southeastern Arizona, in grassland in south-central Texas, and from Sonora and Chihuahua, Mexico. 640-1100m (2100-3600')	*Prosopis juliflora* var. *velutina*	—	—	—	Nutting 1979:308-310; Weesner 1965:59
Incisitermes fruticavus (Rust)	Recently described termite from southern California. 660-700m (2160-2300')	*Simmondsia chinensis*, *Rhus ovata*	—	—	—	Rust 1979
Incisitermes minor[2] (Hagen)	Wide geographical and ecological range, from southwestern California, north to Washington State, east to eastern Arizona, north into Utah, south into Baja, California and west into Sonora, Mexico. 0-1675m (0-5500')	—	Sycamore, walnut, cottonwood, ash, Arizona cypress, Monterey cypress, *Umbellularia californica*, driftwood	*Juniperus deppeana*, pinyon pine, white cedar	maple flooring, pine firewood, hard pine fence, all types of man-made structures	Banks & Snyder 1920: 136; Light 1946b:210; Weesner 1970:488; Wm. Nutting, personal collections.

TABLE 1.–*Ecological and plant-host data on wood-dwelling termites of the Southwestern United States.* (continued)

Type of Termite Family and Species	Geographical Distribution and Elevational Range	Observed Plant Hosts of Various Natural Habitats and Man-made Habitats/Structures				References
		Desert	Riparian	Mountain	Introduced Plants or hosts provided by humans	
Marginitermes hubbardi[3] (Banks)	Wide geographical range, in low and dry areas of the desert Southwest, from Baja, California to western Mexico, south to Jalisco and from extreme southeastern California across southern Arizona to extreme southwestern New Mexico. 0-1130m (0-3700')	Paloverde, saguaro, cardon	Willow, cottonwood, walnut, sycamore, Arizona ash	–	Western red cedar shakes, teak boat deck, furniture, railway cars, grapevines, mulberry, corn plants, douglas fir stored in Phoenix lumberyard, rafters in adobe structures	Banks & Snyder 1920: 137-139; Weesner 1970: 485; Wm. Nutting, personal collections.
Pterotermes occidentis[3] (Walker)	Within the general limits of the Sonoran desert in southern Arizona and Baja, California. 0-1100m (0-3600')	*Cereus giganteus, Cercidium floridum, Yucca Whipplei, Y. valida, Agave shawii, Idria columnaris*	–	–	–	Weesner 1970:484; To, et al. 1980:113.
Damp-Wood Termites: Family Kalotermitidae						
Paraneotermes simplicornis (Banks)[3]	A termite of hot, arid regions. Extensive range into southeastern California, southern Nevada, Arizona, Texas, Baja, California, Sinaloa, Mexico. 0-1100m (0-3600')	*Prosopis juliflora, Parosela spinosa, Parosela californica, Atriplex, Acacia greggii*, paloverde, saguaro, cholla	Cottonwood, sycamore, Arizona cypress, *Chilopsis*	–	redwood fence posts, pecan, eucalyptus, pyracantha, apricot, citrus, houses	Light 1937:424; Weesner 1970:486; Wm. Nutting, personal collections.

TABLE 1. –*Ecological and plant-host data on wood-dwelling termites of the Southwestern United States.* (continued)

Type of Termite Family and Species	Geographical Distribution and Elevational Range	Observed Plant Hosts of Various Natural Habitats and Man-made Habitats/Structures: Desert	Riparian	Mountain	Introduced Plants or hosts provided by humans	References
Family Hodotermitidae						
Zootermopsis angusticollis (Hagen)	Abundant in the more humid forested, coastal areas from southern British Columbia to northern Baja, California. 0-1220m (0-4000') in northern part of range; 0-1830m (0-6000') in southern part of range.	–	sycamore, walnut, laurel, maple	redwood, pine, douglas fir, madrone	pear	Light 1946c:314; Castle 1946:275; Wm. Nutting, personal collections.
Zootermopsis laticeps (Banks)	Near watercourses in the southeastern quadrant of Arizona, as far north as Sedona and eastward into Southwestern New Mexico. 460-1675m (1500-5500').	–	*Populus Fremontii, Alnus oblongifolia, Platanus Wrightii, Salix Gooddingii*	–	pecan	Nutting 1965; Wm. Nutting, personal collections.
Zootermopsis nevadensis (Hagen)	In cooler, drier, higher areas in Vancouver Island, British Columbia, south to central California, and from the Pacific coast east to Montana. 0-1830m (0-6000').	–	–	pine, "fir", redwood, *Juniperus*	–	Banks & Snyder 1920: 122-124; Castle 1946: 275; Weesner 1970:482.

[1] Synonyms are *Incisitermes texanus* (Banks) and *I. lighti* (Snyder).

[2] Synonym is *Incisitermes arizonensis.*

[3] Represents a monotypic genus in North America.

FIG. 1.–Sketch of a typical wood-dwelling termite fecal pellet, enlarged approximately 18x normal size. Cross-sectional view (a) reveals hexagonal shape, while parallel ridges are evident on longitudinal view (b).

FIG. 2.–Longitudinal view of modern *Incisitermes minor* termite fecal pellets, magnified 15x their average length of 1.14 mm. Light colored parallel ridges alternate with darker, slightly concave sides.

30x magnification with an ocular micrometer (Table 2). Pellet diameter, measured midway along the length before tapering begins, is generally less variable than pellet length, measured from blunt to tapered end. A larger sample of 200 pellets of *Pterotermes* revealed population statistics nearly identical to those of the smaller 50-pellet sample, suggesting that a 50-pellet sample was representative.

ARCHAEOLOGICAL DISTRIBUTION IN THE AMERICAN SOUTHWEST

Wood-dwelling termite fecal pellets have been clearly documented in a number of archaeological contexts in association with humans in the Southwestern United States (Table 3). These pellets span broad geographical and elevational ranges, and derive from a variety of ancient Southwestern cultural traditions. All pellets are from contexts at least 600 years old, up to perhaps 2000 or more years of age.

Most of the prehistoric specimens appeared charred to investigators (Fig. 3); these ancient organic items probably preserved through time because exposure to fire rendered them unappealing to degradative organisms. At each ancient site, such criteria as context of recovery, carbonized condition, and presence of protective non-cultural sediment over cultural debris were employed to help rule out the possibility that these pellets might be unrelated to the period of site occupation. A few tan specimens, apparently not carbonized, were also judged to relate to site occupation by the criteria of site context and location beneath protective non-cultural overburden. Preservation of non-carbonized fecal pellets may be due to both pellet content and environment of deposition. Items with a high proportion of lignin are not a food resource for most organisms, although some Basidiomycetes can thrive on lignin (Leo and Barghoorn 1976:4). Because these fungi function optimally only in moist, aerobic settings, termite fecal pellets buried in dry, oxygen-restricted sediments, may have been unable to support decomposers.

TABLE 2.–*Diameter and length measurements on 50-pellet samples of eight wood-dwelling Southwestern termites.*

Species	Pellet diameter (mm)			Pellet length (mm)		
	Range	x̄	σ	Range	x̄	σ
Pterotermes occidentis (Walker)	.59 - .83	.71	± .06	1.17 - 1.57	1.37	± .10
Zootermopsis angusticollis (Hagen)	.56 - .82	.69	± .063	.89 - 1.31	1.10	± .103
Zootermopsis laticeps (Banks)	.55 - 1.07	.81	± .13	.98 - 2.14	1.56	± .29
Incisitermes minor (Hagen)	.54 - .74	.64	± .048	.93 - 1.35	1.14	± .104
Marginitermes hubbardi (Banks)	.53 - .69	.61	± .04	.82 - 1.10	.96	± .068
Paraneotermes simplicornis (Banks)	.45 - .61	.53	± .04	.51 - 0.87	.69	± .09
Incisitermes banksi (Snyder)	.40 - .56	.48	± .04	.63 - 0.91	.77	± .07
Incisitermes fruticavus (Rust)	.40 - .56	.48	± .04	.70 - 1.00	.85	± .076

FIG. 3.–Longitudinal view of prehistoric charred termite fecal pellets from a site along the Gila River near Florence, Arizona. Although the pellets are magnified 17x their average length of .87 mm, they probably shrank when burned. Sometimes ancient pellets occur fused to one another.

CULTURAL SIGNIFICANCE OF TERMITE FECAL PELLETS IN ARCHAEOLOGICAL SITES

Two possible routes of introduction of termite fecal pellets into ancient dwellings include transport in locally gathered firewood, and infestation of roof or side-wall construction material.

Firewood.–Shrubs and trees brought in for firehearth fuel may have provided one very likely avenue for termite debris to enter a dwelling. Both living and dead termite colonies

TABLE 3.—*Termite fecal pellets in association with ancient human habitations in the Southwestern United States.*

Site Name	Location and Elevation	Main Vegetation Today	Cultural Affiliation and Time	Context of Recovery	Average length and width (mm) of pellets; notes; condition of pellets[1]	References
Hay Hollow	Central Arizona, near Snowflake; 1750m (5750')	Scattered pinyon and juniper, with *Sporobolus* grassland.	Mogollon Tradition; small house clusters of hunters and gatherers; 300 B.C.-300 A.D.	On floor or entryway of two structures, and in 7 separate firepit samples, plus 1 burial.	.77 x .495 (n=10); three are conical; Charred.	Bohrer 1972:23 as "Tule Springs Unknown"
La Ciudad	Arizona, along the Salt River, near Phoenix; 335m (1100')	Paloverdes and urban vegetation in the Lower Sonoran Life Zone.	Riverine Hohokam Tradition; sedentary agriculturalists; 900-1100 A.D.	Fourth most common item in over 70 1-2 liter dirt samples from trash areas. Also in 1 of 8 pit house floors.	.84 x .52 (n=17); Charred.	Gasser 1981 as "Tule Springs Unknown"
ARIZ U:15:19	Arizona, along the Gila River near Florence; 460m (1500')	*Larrea, Cercidium,* and saguaro.	Hohokam Tradition, Civano Phase; post 1300 A.D.	Feature 509 (SN498), a surface structure that burned down; burial inside.	.86 x .53 (n=6); plus 3 clusters of 8-10; Charred.	Charles Miksicek unpublished data.
				Hearth (SN497), in structure 509.	.87 x .49 (n=5); Charred.	Charles Miksicek unpublished data.
				Feature 522(SN3114), surface structure.	.83 x .53 (n=13) clusters; Charred.	Charles Miksicek unpublished data.
					1.60 x .75 (n=1); Charred.	Charles Miksicek unpublished data.
ARIZ U:15:87	Arizona, along the Gila River near Florence; 460m (1500').	*Larrea, Cercidium,* and saguaro	Hohokam Tradition, Soho Phase; 1150-1250 A.D.	Feature 20 (SN401), a post-reinforced pithouse.	1.90 x .93 (n=2); Charred.	Charles Miksicek unpublished data.
Fresnal Shelter	New Mexico, in Sacramento Mts. near Alamogordo; 1920m (6300')	*Larrea, Prosopis, Juniperus,* pinyon and grasses.	Archaic Hunting and Gathering Tradition; limestone rock shelter; 1600 B.C.-1 A.D.	Grass-lined cist, Cat. No. 01.C26.85. Disturbed area, Cat. No. 01.C30-22. Cat. No. 01.C31.18	1.12 x .57 (n=2); Tan 1.10 x .60 (n=1); Charred. 1.00 x .60 (n=1); Charred.	Bohrer 1981 as "Tule Springs Unknown"; Irwin-Williams 1979:41

TABLE 3. - *Termite fecal pellets in association with ancient human habitations in the Southwestern United States.* (continued)

Site Name	Location and Elevation	Main Vegetation Today	Cultural Affiliation and Time	Context of Recovery	Average length and width (mm) of pellets; notes; condition of pellets[1]	References
Salmon Ruin	New Mexico, near Farmington; 1780m (5840')	*Juniperus, Atriplex, Artemisia* and grasses.	Anasazi Tradition, sedentary agriculturalists; stone and adobe pueblo; 1100-1300 A.D.	In 25 of 64 flotation samples from floors and trash.	.85 x .41 (n=4); Some charred; others tan.	Adams 1980a; Adams 1980b; Bohrer & Adams 1977:199 as "Tule Springs Unknown"

[1] All pellets measured by the author.

would be expected to harbor some pellets in the colony chambers and passageways; burning might slowly heat these protected pellets as the fire etched into the fuel source. Eventual carbonization of the pellets might result. The irregular occurrence of charred termite pellets in samples from a site in Phoenix, Arizona (Gasser 1981:359) could reflect the occasional use of termite-infested wood for hearth fuel. Charred pellets in seven separate fire-pit samples at a site near Snowflake, Arizona (Bohrer 1972), may also owe their presence to this mode of introduction.

Infestation of Wooden Roof Beams and Wall Supports.—Perhaps ancient dwellers in the Southwest experienced termite damage to various parts of their homes or towns. Puebloans of the Anasazi Tradition, as evidenced at Salmon Ruin in northwestern New Mexico, built stone and adobe towns that had multi-layered roofs of plant materials. For example, one room had a roof that consisted of a basal layer of large wooden beams (vigas) of *Pinus, Juniperus* and *Pseudotsuga* (douglas fir), topped by smaller trunks (latillas), a layer of *Salix* (willow) twigs, and finally *Juniperus* bark, all interspersed with mud and dried plant parts (Adams 1980c). Such a roof, many meters above ground level and supported by sturdy walls of adobe and stone, was vulnerable to attack by termites. Airborne infestation by wood-dwelling termites could be signaled by hexagonal fecal pellets that might drop to floors below and be recovered in soil samples taken centuries later. While Dr. William Robinson of the Laboratory of Tree-Ring Research in Tucson, Arizona has not observed termite damage in any of the large prehistoric beams taken from structures in the Chaco, Mesa Verde or Kayenta Cliff Dwelling areas (Letter Jan. 8, 1982), perhaps the smaller latilla or twig layers provided suitable nesting sites. Finding termite-galleried wood in ancient roof debris is needed to confirm this hypothesis.

Prehistoric dwellers of the Hohokam Tradition in Arizona built structures unlike the communal pueblos of the Anasazi. Single houses, often partially sunken into the ground, were common among the Hohokam. The side walls of dwellings constructed at Snaketown, a large Hohokam town in central Arizona, were fashioned of such plants as *Populus* (cottonwood) and *Prosopis* (mesquite), and occasionally of *Juniperus*. Mesquite and cottonwood were also used for the overhead rafters and lighter layers that comprised the roof (Sayles 1938:81; Haury 1978:72). One can speculate that these plant materials may have housed termites.

ENTOMOLOGICAL/ENVIRONMENTAL SIGNIFICANCE

The broad geographic and elevational distribution of termite fecal pellets in the archaeological record posed the intriguing possibility of discerning the prehistoric distribution pattern of termites. Entomologists might appreciate a prehistoric biogeographical view of termite range, while archaeologists might have yet another means to infer local site conditions by knowing what termites lived nearby. Length and width measurements of modern pellets were secured to determine if one or perhaps a few of the species could be distinguished from all others. The resulting dichotomous key based on modern termite pellet population statistics (Fig. 4) revealed that, as with any naturally varying group of organisms, some species had unique attributes while others had pellets with characteristics shared in common by one or more species.

The real problem with identifying ancient termites from their pellet morphology does not lie with overlapping population characteristics however. Carbonization experiments performed on carefully measured populations of modern pellets revealed that shrinkage in both length and width dimensions can be moderate to severe (Table 4), depending upon amount of oxygen present and length of time exposed to fire. The variable nature of termite pellet shrinkage parallels that found by researchers undertaking modern seed carbonization experiments. Seed size changes due to burning vary with inherent seed differences (Renfrew 1973:11-13), moisture content (Stewart and Robert-

1. Diameter .40-.45mm	*Incisitermes banksi, I. fruticavus*
1. Diameter greater than .45mm	2.
2. Diameter .45-.53mm	3.
2. Diameter greater than .53mm	4.
3. Length .51-.87mm, conical shape	*Paraneotermes*
3. Length .63-1.00mm, rectangular	*Incisitermes banksi, I. fruticavus*
4. Diameter .53-.61mm	5.
4. Diameter greater than .61mm	14.
5. Length greater than .93mm	6.
5. Length less than .93mm	11.
6. Length .93-.98mm	*Marginitermes, I. minor, I. fruticavus, Zootermopsis angusticollis*
6. Length greater than .98mm	7.
7. Length .98-1.10mm	*Marginitermes, I. minor, Z. laticeps, Z. angusticollis*
7. Length greater than 1.10mm	8.
8. Length 1.10-1.17mm	*I. minor, Z. laticeps, Z. angusticollis*
8. Length greater than 1.17mm	9.
9. Length 1.17-1.35mm	*I. minor, Z. laticeps, Z. angusticollis, Pterotermes*
9. Length greater than 1.35mm	10.
10. Length 1.35-1.57mm	*Z. laticeps, Pterotermes*
10. Length greater than 1.57mm	*Z. laticeps*
11. Length less than .63mm, conical	*Paraneotermes*
11. Length .63-.93mm	12.
12. Conical shape	*Paraneotermes*
12. Rectangular shape	13.
13. Length .63-.82mm	*I. banksi, I. fruticavus*
13. Length greater than .82mm	*I. banksi, I. fruticavus, Marginitermes, Z. angusticollis*
14. Diameter .61-.74mm	15.
14. Diameter greater than .74mm	16.
15. Length less than .93mm	*Marginitermes, Z. angusticollis*
15. Length greater than .93mm	6.
16. Diameter .74-.83mm	17.
16. Diameter greater than .83mm, length .98-2.14mm	*Z. laticeps*
17. Length less than 1.17mm	*Z. laticeps, Z. angusticollis*
17. Length greater than 1.17mm	18.
18. Length 1.17-1.57mm	*Z. laticeps, Z. angusticollis, Pterotermes*
18. Length greater than 1.57mm	*Z. laticeps*

FIG. 4.–Dichotomous key to whole, uncarbonized modern fecal pellets from wood-dwelling termites living in the Southwestern United States.

TABLE 4.—*Mean size measurements of modern termite fecal pellets before and after exposure to heat.*

Dimension	Oxygen-rich carbonization[1] of *Incisitermes minor* pellets			Anaerobic carbonization[2] of *Pterotermes occidentis* pellets		
	Before Exposure (n=50)	After Exposure (n=50)	% Shrinkage	Before Exposure (n=50)	After Exposure (n=37)	% Shrinkage
Length	1.14 mm	1.06 mm	7	1.26 mm	.86 mm	32
Diameter	.64 mm	.60 mm	6.6	.73 mm	.51 mm	30

[1]Carbonized in a coffee can over an electric hot plate for three minutes.

[2]Carbonized inside aluminum foil buried in hot coals for over one hour.

son 1971:381), as well as maturity, evenness of carbonization and total amount of charring (Brugge 1965:49). It would be impossible to know, in this case, how much shrinkage had been experienced by pellets recovered from the ashes of an ancient firepit. Since the bulk of pellets recovered from Southwestern archaeological sites to date have been carbonized[1], at present the size dimensions give no clues to the identity of the termites. As uncarbonized pellets are recovered, however, they should be classified in the hopes that both environmental information and the distribution of prehistoric termites may become known.

TERMITES AS AGENTS IN THE DISTURBANCE OF ARCHAEOLOGICAL SITES

In addition to suggesting prehistoric termite biogeography, abundant uncarbonized pellets in an ancient site might serve as a clue to pre or post-depositional modification of strata. For example, wood-dwelling termites could easily inhabit dense organic deposits that are typical of dry caves or rock overhangs in the American Southwest. As termites utilized buried wood, sediment mixing could occur as internal, now-empty spaces collapsed downward. The archaeologist should consider such a natural transformation process in deposits that reveal broad distribution and fair numbers of uncarbonized pellets.

Earth-dwelling termites could also play a major role in soil mixing of non-cave archaeological sites, where moisture content is generally higher. Termites in North America have been known to mix, alter, invert and obliterate soil horizons, as well as create new horizons and affect the spatial boundaries of different soils (Wood and Johnson 1978:325). Not only might termites mix soils, but they could also provide channels for air and water to move downward through deposits and thus increase chances of oxidation of organic material and destruction by fungi and bacterial degradative organisms. Since earth-dwelling termites do not produce recognizable six-sided fecal pellets, spotting their former presence in a site would be difficult.

SUMMARY

Fecal pellets from wood-dwelling termites had been isolated from Southwestern United States archaeological soil samples for at least ten years before their identification was secured. Potential avenues for the introduction of termite fecal pellets into ancient

dwellings include plant materials carried in as fuel, and infestation of roof or wall supports. Often the pellets are charred in ancient deposits. Carbonization experiments performed on modern pellets in the presence and absence of oxygen reveal that termite pellets shrink from 6-30% in both length and diameter. Therefore, the possibility of inferring ancient termite distribution from the morphology of carbonized pellets from archaeological sites seems remote. While this particular record is mute regarding biogeographical and ecological data, other non-burned records may not be so. In a dry site, such as a cave or rock overhang, widespread occurrence of non-burned pellets could signal extensive termite colonization and potential mixing of site deposits. The identification and interpretation of insect remains from archaeological sites remains a largely unexplored, and undoubtedly rich, source of information.

ACKNOWLEDGMENTS

The keen sense of observation of Mr. Alan C. Reed, while a graduate student at Eastern New Mexico University, provided the first clue that an unknown item from a number of Southwestern archaeological sites might derive from termites. Without reservation Dr. William L. Nutting of the Department of Entomology, University of Arizona, confirmed the hunch. Dr. Nutting also provided guidance and, along with Dr. Michael K. Rust of the University of California, Riverside, supplied me with modern termite fecal pellets for examination. Vorsila L. Bohrer not only recovered and described the first "Tule Springs Unknown" specimens, she also served as the catalyst for this study. My parents Louise and Adrian Rogers assisted with technical details, and Cynthia Lindquist photographed the modern and ancient pellets. Colleagues in ethnobiology, noted in Table 3, kindly sent me ancient termite pellet specimens for scrutiny.

LITERATURE CITED

ADAMS, KAREN R. 1980a. Pollen, Parched Seeds and Prehistory: a pilot investigation of prehistoric plant remains from Salmon Ruin, a Chacoan pueblo in northwestern New Mexico. Eastern New Mexico Univ. Contributions in Anthropology 9.

———. 1980b. Relative numbers of native microfossils in strata of poor preservation, with emphasis on flotation. Pp. 251-301 *in* Investigations at the Salmon Site: The Structure of Chacoan Society in the Northern Southwest, vol. III. Final report to funding agencies (C. Irwin-Williams and P. H. Shelley, eds.). Ms on file, Eastern New Mexico Univ., Portales.

———. 1980c. Pines and other conifers. Pp. 355-562 *in* Investigations at the Salmon Site: The Structure of Chacoan Society in the Northern Southwest, vol. III. Final report to funding agencies (C. Irwin-Williams and P. H. Shelley, eds.). Ms on file, Eastern New Mexico Univ., Portales.

BANKS, N. and T. E. SNYDER. 1920. A revision of the Nearctic Termites, with notes on their Biology and Geographic Distribution. Bull. U.S. Nat. Mus. 108:1-228.

BOHRER, VORSILA L. 1972. Paleoecology of the Hay Hollow Site, Arizona. Fieldiana, Anthr. 63(1):1-30.

———. 1981. Former Dietary Patterns of People as Determined from Archaic-Age Plant Remains from Fresnal Shelter, South-Central New Mexico. Ms on file, Eastern New Mexico Univ., Portales.

BOHRER, VORSILA L. and KAREN R. ADAMS. 1977. Ethnobotanical Techniques and Approaches at Salmon Ruin, New Mexico. Eastern New Mexico Univ. Contributions in Anthropology 8(1).

BRUGGE, DAVID M. 1965. Charred Maize and "Nubbins". Plateau 38(2):49-51.

CASTLE, GORDON B. 1946. The dampwood termites of western United States, genus *Zootermopsis* (formerly *Termopsis*). Pp. 273-310 *in* Termites and Termite Control (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

GASSER, ROBERT E. 1981. Hohokam Plant Use at La Ciudad and other Riverine Sites: the Flotation Evidence. Appendix IV. Pp. 341-380 *in* Archaeological Investigations, Arizona Department of Transportation, Phoenix. Testing at La Ciudad (Group III), West Papago-Inner Loop (I-10), Maricopa

LITERATURE CITED (continued)

County, Arizona. Ms on file, Museum Northern Arizona, Flagstaff.

HAURY, EMIL W. 1978. The Hohokam. Desert Farmers and Craftsmen. Excavations at Snaketown, 1964-1965. Univ. Arizona Press, Tucson.

IRWIN-WILLIAMS, CYNTHIA. 1979. Post-Pleistocene Archaeology, 7000-2000 B.C. Pp. 31-42 *in* Handbook of North American Indians, Southwest (Alfonso Ortiz, volume ed.). Smithsonian Institution, Washington.

KOFOID, CHARLES A. 1946a. Biological backgrounds of termite problems. Pp. 1-13 *in* Termites and Termite Control (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

———. 1946b. Seasonal changes in wood in relation to susceptibility to attack by fungi and termites. Pp. 564-571 *in* Termites and Termite Control (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

LA FAGE, JEFFERY P. 1976. Nutritional biochemistry, bioenergetics, and nutritive value of the dry-wood termite *Marginitermes hubbardi* (Banks). Unpubl. Ph.D. dissert. (Entomology), Univ. Arizona, Tucson.

——— and W. L. NUTTING. 1977. Nutrient dynamics of termites. Pp. 165-232 *in* Production Ecology of Ants and Termites (M. V. Brian, ed.). International Biological Programme 13. Cambridge Univ. Press.

LEE, K. E. and T. G. WOOD. 1971. Physical and chemical effects on soils of some Australian termites, and their pedological significance. Pedobiologia, BD. 11, S.:376-409.

LEO, RICHARD F. and ELSO S. BARGHOORN. 1976. Silicification of Wood. Bot. Mus. Leaflets, Harvard Univ. 25 (1):1-47.

LIGHT, S. F. 1937. Contributions to the Biology and Taxonomy of *Kalotermes (Paraneotermes) simplicornis* Banks (Isoptera). Univ. Calif. Publ. Entomology 6(16):423-464.

———. 1946a. Habitat and habit types of termites and their economic significance. Pp. 136-149 *in* Termites and Termite Control (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

———. 1946b. The distribution and biology of the common dry-wood termite *Kalotermes minor*. Pp. 210-233 *in* Termites and Termite Control. (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

———. 1946c. Termites and Growing Plants. Pp. 314-320 *in* Termites and Termite Control (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

NASH, OGDEN. 1942. Good Intentions. Little, Brown and Co., Boston.

NUTTING, WILLIAM L. 1965. Observations on the nesting site and biology of the Arizona damp-wood termite *Zootermopsis laticeps* (Banks) (Hodotermitidae). Psyche 72(1):113-125.

———. 1979. Biological notes on a rare dry-wood termite in the Southwest, *Incisitermes banksi* (Kalotermitidae). The Southwestern Entomologist 4(4): 308-310.

RENFREW, JANE M. 1973. Paleoethnobotany. The prehistoric food plants of the Near East and Europe. Columbia Univ. Press, New York.

ROBINSON, WILLIAM J. 1982. Letter in files of author, Jan. 8, 1982.

RUST, MICHAEL K. 1979. A new species of drywood termite from southwestern North America (Isoptera: Kalotermitidae). Pan-Pacific Entomologist 55(4): 273-278.

SAYLES, E. B. 1938. Houses, Chapter VII *in* Excavations at Snaketown. Material Culture (Harold S. Gladwin, Emil W. Haury, E. B. Sayles and Nora Gladwin, authors). Gila Pueblo Medallion Papers No. XXV. (Reprinted in 1965 by Univ. Arizona Press, Tucson).

STEWART, ROBERT B. and WILLIAM ROBERTSON, III. 1971. Moisture and Seed Carbonization. Econ. Botany 25(4):381.

TO, LELENG P., LYNN MARGULIS, DAVID CHASE and WILLIAM L. NUTTING. 1980. The symbiotic microbial community of the Sonoran Desert Termite: *Pterotermes occidentis*. BioSystems 13: 109-137.

WEESNER, FRANCES M. 1965. The Termites of the United States, a Handbook. The National Pest Control Association, Elizabeth, New Jersey.

———. 1970. Termites of the Nearctic Region. Pp. 477-525 *in* Biology of

LITERATURE CITED (continued)

Termites, Vol. II (Kumar Krishna and F. M. Weesner, eds.). Academic Press, New York.

WILLIAMS, O. L. 1946. Wood preference tests. Pp. 572-573 *in* Termites and Termite Control (Charles A. Kofoid, ed.). Univ. California Press, Berkeley.

WOOD, W. RAYMOND and DONALD LEE JOHNSON. 1978. A survey of disturbance processes in archaeological site formation. Pp. 315-381 *in* Advances in Archaeological Method and Theory I (Michael B. Schiffer, ed.). Academic Press, New York.

NOTE

[1]To distinguish naturally black items from those turned black by exposure to heat, one can gently scratch the specimen against a piece of white paper, and a carbonized item will generally leave a slight streak or smudge.

Book Review

The Desert Smells Like Rain: A Naturalist in Papago Indian Country. Gary Paul Nabhan. San Francisco: North Point Press, 1982. 148 pp., illus., $12.50.

From an overture punctuated by spadefoot toads and desert thunderstroms, to a *pastorale* of bird-song around a desert oasis, and a crescendo of *mariachi* and Papago polka bands, **The Desert Smells Like Rain** presents an intimate view of the Sonoran Desert and its native people. Ethnobiologist Gary Nahban shares his experiences and insights while studying run-off agriculture and traditional crops in the borderlands of Arizona and Sonora. These adventures include a trek to *I'itoi's* cave in the Baboquivari Mountains, a visit to a saguaro wine-drinking and rain-bringing ceremony, expeditions to two relic oases in the desert, and a pilgrimage to the *Fiesta* of San Francisco Xavier in Magdalena, Sonora. Along the way he introduces the reader to his Papago acquaintances, who are more friends than just informants.

In other chapters, Gary Nabhan explores the relationship between the disappearance of traditional foods and dietary patterns and the endemic increase of diabetes, cardiovascular problems, and other nutrition-related diseases among the Papago. He also examines the native view of the indigenous wild relatives of important cultivated plants. Wild tepary beans, gourds, cotton, and tobacco are all considered to be plants that Coyote, the trickster deity, has stolen or otherwise spoiled. An important theme throughout **The Desert Smells Like Rain** is Papago cognition of the changing hydraulic regime of the Sonoran Desert and the abandonment of traditional floodwater farming.

Ethnography, germplasm conservation, linguistics, and traditional agriculture are interwoven with insight, myth, and humor in **The Desert Smells Like Rain**. An extensive collection of notes and references is included, but in the back of the book where it doesn't interrupt the flow of the text.

Gary Paul Nabhan should be added to the list of authors that includes Alfred Russel Wallace, Charles Darwin, Edgar Anderson, and Stephen Jay Gould, natural history writers with the unique talent of being able to present a tremendous amount of information in an enjoyable and very readable style.

CHM

Book Review

By the Prophet of the Earth: Ethnobotany of the Pima. L. S. M. Curtin. Tucson: The University of Arizona Press, 1984. 156 pp., illus., $6.95, paperback.

The title, *By the Prophet of the Earth,* pays homage to the Piman diety *Jewed Makai,* the Earth Doctor, whose gifts are celebrated in this book. These gifts provided food, shelter, medicine, and raw materials for the *Akimel O'odham,* "Running Wash People" or northern Pima, and their ancestors for countless millenia in the Sonoran Desert.

Leonora Curtin's book provides descriptions and uses for seventy-six plants, both wild and cultivated, important to Piman culture. She also has accounts of Piman games, legends, and miscellaneous beliefs. One chapter is devoted to material culture, from houses to ceremonial rattles, with brief descriptions of how these are made and the plants that are used. Scientific, Piman, and Anglo or Spanish common names are given for each species.

By the Prophet of the Earth was first published in 1949, and most of the field research was conducted immediately before World War II. This was the period of time when the impact of Anglo diet, with its dubious gifts of white bread, canned goods, and convenience good, was first being felt on the Piman reservation. L. S. M. Curtin hoped that her book would both preserve some of the native Piman dietary knowledge and also awaken a scientific interest in evaluating its nutritional "virtues". The new forward to the book, written thirty-five years later by ethnobiologist Gary Nabhan, suggests that some of this latter purpose has been accomplished. Recent research published by Doris Calloway, Ruth Greenhouse, Harriet Kuhnlein, Charles Weber, and their collaborators has demonstrated that native Piman foods, prepared in traditional ways, are nutritionally comparable or superior to modern Anglo foods now available on the reservation. Native plant foods were seasonally important sources of vitamins, trace elements, carbohydrates, essential oils, and high quality proteins. A recent study in Mexico (*Arizona Daily Star,* p. 8D, May 27, 1984) has suggested that a 100 gram serving of prickly pear pads can reduce 60 mgs. of glucose in the blood of diabetics, demonstrating another link between traditional diets and the reduction of nutrition-related diseases. Robert Corruccini and his colleagues reported that older Pimans raised on traditional diets had better overall dental health than younger individuals who consumed refined commercial foods (*Am. J. of Physical Anthropology* 62(3):317-324, 1983).

This edition of *By the Prophet of the Earth* is a direct photographic reproduction of the original text, with a new foreward by Gary Paul Nabhan. With the recent publication of Amadeo Rea's *Once a River,* this re-issue of Curtin's book, and forthcoming works by Richard Felger on Seri ethnobotany and Alfred Whiting on Havasupai habitat, The University of Arizona Press is rapidly becoming a leader in ethnobiological publications.

CHM

J. Ethnobiol. 4(1):45-60 May 1984

THE PRAGMATICS OF FOLK CLASSIFICATION

BRIAN MORRIS
Goldsmiths' College
University of London
New Cross London SE14 6NW, England

ABSTRACT.—In an examination of Chewa folk biological classifications, specifically those relating to the fungi, the paper suggests that functional criteria are intrinsic to their taxonomic ordering, and that their mode of classification is essentially prototypical rather than categorical and hierarchic.

INTRODUCTION

In 1925, almost sixty years ago, Malinowski (1974:44) wrote: "The road from the wilderness to the savage's belly and consequently to his mind is very short. For him the world is an indiscriminate background against which there stands out the useful, primarily the edible, species of animals and plants." There has been a justified, though perhaps unnecessarily harsh, reaction against this kind of pragmatism. No one has expressed this better than Levi-Strauss, who has argued that the outlook of pre-literate peoples towards the natural world is primarily intellectual, and that totemic symbols cannot be understood in terms of a naturalistic perspective. For Levi-Strauss (1966:9) the "specific" character of the animal and plant world is the initial source or impulse for symbolic classifications, but the main purpose of these classifications is not a practical one: "It meets intellectual requirements rather than . . . satisfying needs."

Of equal interest, however, is the viewpoint of the ethnoscientists, such as Brent Berlin and his associates (1974). Although stemming from a different theoretical tradition—that of Anglo-Saxon empiricism—the latter share with the structuralists an interest in folk classifications. As with Levi-Strauss, folk knowledge is seen primarily in classificatory terms, and there is an equal stress on a logic of what Levi-Strauss (1969:163) calls "oppositions and correlations, exclusions and inclusions . . .", that is, on systematics and coherence. Furthermore, though focusing on specific semantic domains, they have other affinities with Levi-Strauss in their search for universals, reflecting a consistent and healthy opposition to cultural relativism. Similarly, like Levi-Strauss, ethnoscientists see folk classifications as expressing a purely intellectual interest in the natural world. Whereas for Malinowski (1925), pre-literate people appear to think through the stomach, Levi-Strauss and the ethnoscientists view the interest in the world of pre-literate people as cognitive and intellectual and, divorced from pragmatic concerns, as being related primarily to a "search for order". Neither tradition, of course, denies that animals and plants have a utilitarian significance, e.g., food or medicines, but both imply that this is largely unrelated to the way that people systematically classify the natural world.

Given the different philosophical perspectives of the ethnoscientists and the structuralists, the two traditions naturally advocate a different kind of intellectual and classificatory mode. For Levi-Strauss, pre-literate people are concerned with a mode of thinking that unifies through symbolic logic diverse aspects of their culture; for Berlin and his associates (1974), on the other hand, subjects are proto-botanists concerned with ordering the natural world through criteria based on morphology and structure. Both of these perspectives have been necessary, but they have also limited our understanding of folk classifications. The structuralist approach, by focusing on the symbloic logic, over systematizes the social reality and tends to ignore the praxis of human groups. The approach of the ethnoscientists, on the other hand, has tended to underplay the relevance of practical interests in the structuring of folk taxonomies. My aim in this paper is to focus on the latter issue and to show, through an examination of the natural taxonomies of the Chewa people of Malawi[1] that pragmatic concerns are highly relevant in interpreting the nature and structure of folk classifications, echoing some of Bulmer's (1974) early misgivings about ethnoscience.

TWO ILLUSTRATIONS OF FUNCTIONAL CATEGORIES

In an article on the uses of succulent plants in Malawi, one biologist, Hargreaves (1976:190), admitted that he found local plant nomenclature somewhat confusing. He wrote:

> I found, for example, that a small herbaceous mint, a shrub, a grass and the large tree *Acacia albida* were all referred to as *'Mbeya'*. These plants were totally unrelated and showed no resemblance to each other. I was therefore puzzled until an informant told me to taste them. Then it became clear. *'Mbeya'* means 'salt'! I soon learned to overcome my own taxonomic prejudice and look at plants according to their uses. Many plants in Chitipa, in fact, have no local name because they have no use.

And he goes on to state that "Botany grew from herbals listing useful plants and did not arise out of the objectivity which modern scientists like to pretend to."

It would be easy, of course, to dismiss these suggestions as untenable. Some plants in Malawi, as elsewhere, have names but no apparent utility, e.g. the parasitic ***Kamfiti***, *Striga Asiatica.* Clearly there is no simple correlation, as Hargreaves seems to imply, between utility and nomenclature. Nonetheless, it is important to realize, as Brokensha and Riley (1980:121) write of the Mbeere, that utility is a major factor in the classification of plants.

One could also perhaps question Hargreaves on his knowledge of the local language, and suggest that ***Mbeya*** is not a plant name at all, since it means salt; the term, significantly, is not in the Malawi 'Dictionary of Plant Names' (Binns 1972). Indeed, some have thought it important to indicate the semantic confusions that appear to have crept into local floras, when terms were discovered which meant 'medicine' or 'poison' or are the name of some local disease or complaint (cf. Carrington 1981). These, it is suggested, cannot possibly be taxonomic labels! Although offered as criticisms of botanists, such suggestions indicate a stringent taxonomic outlook. After all, no one disputes that such English terms as "heartsease", "eyebright", "sanicle" (from Latin verb *sano*, heal), "gum", "rubber", "wormwood" and "liverwort" are valid plant names–not to mention those terms that have long since disappeared from our vocabulary, e.g., "nosebleed" (yarrow). It is therefore somewhat misleading to assume that terms like "poison" or "salt" or the name of some disease do not have taxonomic significance in folk classifications; indeed it is my contention that they do, which brings me to my second illustration.

Some years ago while studying the epiphytic orchids of Malawi (Morris 1970), I noticed that many of these plants were well-known to local people, and that the commoner species–*Angraecopsis parviflora, Cyrtorchis arcuata, Bulvophyllum sanderonii*–though morphologically quite distinct, were referred to by the collective term ***Mwana wa mphepo***, meaning "child of the wind". Given my ecological bias, I thought it quite an appropriate term for epiphytic orchids, many of which grew high on the outer branches of trees. Many years later I discovered that this term was applied to several other plant life forms–herbs, shrubs and climbers–and was not restricted to epiphytic orchids. Focused on the family Vitaceae, the herbs *Cyphostemma junceum* and *Ampelocisus obtusa* being prototypical, many of these plants, but not all, are referred to by other generic terms (Table 1.). Plants referred to as ***Mwana wa mphepo*** belong, therefore, to

TABLE 1.—*Outline of the taxon mwana wa mphepo*

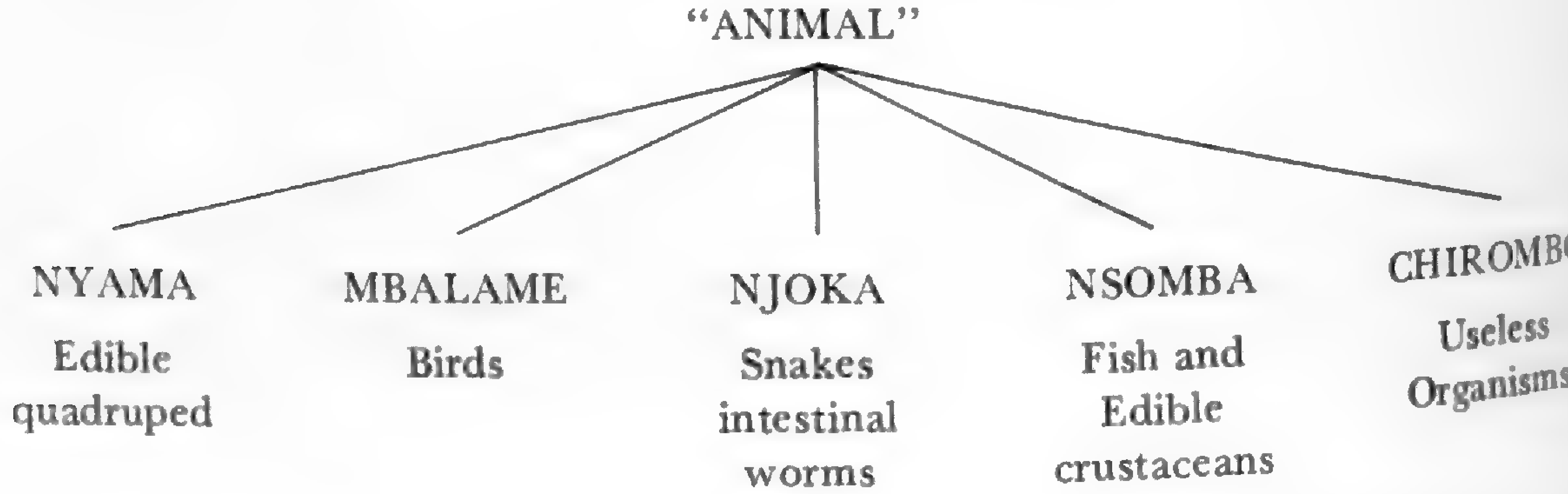
	CHIWAMASIKA	Ampelocisus obtusata	
		Cyphostemma crotalarioides	
		Cyphostemma zombensis	
	MPELESYA	Rhoicissus tridentata	MPESA
			MPETE
		Cissus cornifolia	
		Cissus integrifolia	
		Cissus quadrangularis	MTHAMBE
		(Cissus rubiginosa)	
	NDEMIKANGONO	Cissus buchananii	
		Cyphostemma junceum	MWINIMUNDA
			MWANANKALI
	NCHOFU	Cyphostemma subciliatum	
		Cayratia gracilis	NTEREVERE
MWANA WA MPHEPO			
	Angraecopsis Parviflora		
	Cyphostemma gigantophyllum		
	Cyphostemma rhodesiae		
	Ampelocissus africana		
	Rhoicissus tomentosa		
	Cissus cucumerifolia		
	Cissus faucicola		
	Cissus producta		
	Cissus trothae		
	Cissus aristolochitolia	KAMUTU	
	Rhoicissus revoilii	NTUTOMUKO	
		MDYAPUMBWA	
	Jateorhiza bukobensis	NJOKA	
		KASANA	
	Tinospora caffra	CHIDYAKAMBA	
	Bulbophyllum sandersonii	KALISACHI	
	Crytorchis arcuata	KALISACHI	
		MWANAMVULA	
	Adenia gummifera	MKUTA	
		MLOZI	
	Elephantotthiza goetzei	CHITETE	
		CHALIMA	
	Paullinia pinnata	MKANDANKHUKU	
	Pyrenacantha kaurabassana	CHITUPA	
		NAKULUNGUNDI	

several distinct families, and each one is used as a medicine in the treatment of a disease which is called by the same term, and which is as complex as the plant taxon. The important point is that ***Mwana wa mphepo*** is a polysemic term, and it is quite contrary to Chewa thought to consider plants and diseases as somehow utterly distinct and exclusive domains (cf. Turner 1967:299-358). Many plant categories do indicate their utility, and one herbalist I knew categorized the plants she used either by the term ***(Mtengo) Wazilengo*** (relating to misfortunes caused by medicines) or by the term ***(Mtengo) wa madzoka*** (of the spirit induced illness Madzoka). For these particular trees she never used, or indeed knew, any other term. To understand Chewa folk concepts, therefore, one has to accept that they have a pragmatic dimension, and that such taxonomies are not conceptually isolated, as a domain, from other aspects of Chewa culture.[2]

ZOOLOGICAL LIFE FORMS

As with many other cultures, there are no terms in Chewa that can be considered equivalent to the English terms 'animal' and 'plant', which derive from Latin and were used widely only toward the end of the 16th Century (cf Morris 1980). The Chewa have a concept of life *(- **Moyo**)* and in many contexts use terms that imply a distinction between the two main types of living organisms. The noun-classes themselves to some extent reflect this distinction. Whereas many animals belong to the ***Munthu*** class ***A/Fisi, A/Nyalugwe, A/Mende*** (hyena, leopard, creek rat), most of the ***Mtengo*** category—which includes the majority of the plants known to the Chewa—belong to a different noun class (typically referred to as the ***Mtengo*** class) such as ***Mkuyu, Mkundi, Msopa, Mlombwa*** (all taking the plural prefix Mi-). As in other languages, there are a host of terms referring both to plant morphology and usage and to plant growth that would imply a distinction between plants and other organisms, but whether such distinctions warrant the label of "covert" category (Berlin et al 1968, 1974; Brown 1974) is difficult to say.

The main life-form categories of the Chewa are as follows:



Nyama is a polysemic term referring both to meat and to any edible species of mammal. It can include edible reptiles and amphibians but it excludes ***Nsomba*** (fish and edible freshwater crustaceans), ***Mbalame*** (birds) and ***Njoka*** (snakes). ***Nyama*** has a complex meaning: and in normal contexts it excludes the larger predatory mammals, e.g., hyena, leopard, and lion, as well as those smaller animals not usually eaten, like the mongoose and jackal. It also has a great ritual significance to the Chewa because of its association with hunting. Schoffeleers (1968) suggests that besides meaning "edible quadruped", it refers to the spirit or power released by the blood of a slain person—thus giving the concept a mystical quality. Significantly the "flesh" of a bird, snake or a vegetable substance is not referred to as ***Nyama*** but as ***Mnofo***. Besides these four main life forms—to call them zoological drastically narrows their meaning—there is a kind of residual category ***Chirombo***, which refers to any hostile wild animal; ***Nyalugwe*** (leopard) and ***Fisi*** (hyena) are prototypical. Essentially however, ***Chirombo***, means any useless living thing, and also includes weeds and most invertebrates; like ***Nyama***, the term also has important symbolic connotations, being associated with evil spirits and with the masked dancers (who impersonate spirit animals) at certain ceremonies.

"Within" these categories a distinction is made between wild and domesticated species. Domesticated animals are referred to as ***Chiweto*** or ***Chifuyo***; the latter terms include chickens, ducks and dog, as well as the larger livestock like goats and cattle. For example ***Bakha*** refers to the domestic duck, and besides being seen as outside the ***Mbalame*** (bird) category, is considered quite distinct from wild species such as ***Chipweyo***, the fulvous tree duck and ***Kalanga***, the Hottentot teal. Europeans often use ***Bakha*** as a generic term, but Chewa-speakers around Lake Chilwa were adamant that the term ***Bakha*** applied *only* to the domesticated species.[3] This conceptual demarcation is common amongst the Chewa; ***Nkhumba*** and ***Nguluwe***, for example, refer to the domestic and wild pig respectively and ***Nkhunda*** and ***Njiwa*** to the domestic and wild pigeon. The distinction between the village ***(Mudzi)*** and woodland ***(Thengo)*** is indeed an important ecological and symbolic demarcation amongst the Chewa, and it is a division that has wide cross cultural reference (cf. Strathern 1980).

In an important sense, then, three of the five life form categories which I have briefly discussed above are largely functional categories that cannot be understood simply in terms of morphological criteria. The polysemous nature of the main category ***Nyama*** suggests, as Bulmer remarked, that such 'life-forms', "may be defined as much by cultural evaluation . . . as by their objective biological characteristics" (1974:23). Needless to say, in Chewa thought people ***(Anthu)*** form a separate and unique category.[4]

BOTANICAL LIFE FORMS

There is no term in Chewa for "plant" although literate speakers of the language often try to find or make one. Thus the terms ***Chomera*** or ***Chimerara*** (derived from *Ku-mera*, to sprout or shoot) can be used to describe plants generally but their focus is essentially on cultivated species, especially those like the sweet potato which are propagated vegetatively. These terms have no general use. There are three basic terms in Chewa for what might loosely be described as the plant world: ***Mtengo***, which, at a superficial level, is a general category for trees and woody plants, ***Maudzu***, grasses, and grass-like herbaceous plants like the anthericum lilies, and ***Bowa***, edible fungi.

The majority of plants known to the Chewa fall under the category ***Mtengo***, and in addition to trees, it includes vines, creepers and small herbs. It also refers to a stick, the woody stem or a piece of wood; the allied concept ***Thengo*** is a general term for woodland dominated by the genera *Brachystegia* and *Uapaca* (not "bush" as it is usually translated), as distinct from evergreen forest ***Nkhalango***. The term ***Chire*** is more frequently used to refer to regenerate bushland.

To understand the meaning of ***Mtengo***, however, one has to shift one's perspective, and view the natural world not only in terms of morphology but also in terms of utility. Many small herbs that are utilized as food or medicines are referred to as ***Mtengo***, although they are not trees in the European sense. In a program on Malawi radio on January 10, 1972, a professor of botany was interviewed in English about her work and writings. Part of the discussion was focused on the plant *Galinsoga parviflora* which has the quaint name ***Mwamuna aligone*** (literally 'My husband is sleeping') whose leaves form a useful relish dish. Throughout the discussion the Malawian interviewer described the plant as a 'tree' yet it is only a small slender herb, barely six inches high.

Many herbs, however, do not fit into the ***Mtengo*** category. If a local person is asked what sort of plant, say, a balsam is, or whether a generic category is a 'tree' ***Mtengo*** the informant may be hesitant, and may conclude that it is a ***Maluwa*** (flower), significantly using the plural. So in a sense *Duwa* or *Luwa* (flower—singular form) can take on the role of a general plant category, although many small herbs remain essentially unaffiliated. Many Europeans are surprised to discover, therefore, that many conspicuous plants such as *Gloriosa virescens, Crinum pedicellatum* and *Crocosmia aurea* have no name, and are virtually unnoticed and unrecognized by Chewa speakers (cf. Brokensha and Riley 1980; 121) who yet, somewhat paradoxically, have such a detailed and accurate knowledge of the plant world. The reason is that ***Mtengo*** is essentailly, that is prototypically, a category of useful wild plants, and that *Crocosmia aurea* (for example), which has no evident uses, has no name and is not a 'tree'.

Two other words are often used almost interchangeably with that of ***Mtengo***. The first is ***Mankhwala***, which may be translated as "medicine", and includes both animal and plant material. Medicines and their uses permeate Chewa culture, and are utilized for protection against witchcraft ***(Ufiti)***, as good luck charms and in the treatment of illness and disease. I have often, in pointing to a shrub or tree, asked someone 'What's this?' ***(Ichi ciani?)*** only to get the reply "***Mankhwala***", and many of my Yao informants in Malawi used the term ***Mtera*** which is a generic concept for both "medicine" and "tree". Such polysemy seems widespread in Africa, and in his classic study on the Azande Evans-Pritchard (1937:440) notes:

> "The Zande word which I have translated as 'medicine' or 'magic' according to context is ***Ngua***. ***Ngua*** means 'tree' or 'wood' or 'plant' so when we ask a Zande what medicine is used for a certain activity we are asking him what tree or plant is used."

But if we concentrate, like Evans-Pritchard, on the magic, or like the ethnoscientists on the botany, we miss, I think, the essence of Chewa thought in which medicines and plants are intimately linked.[5] The second word which is used almost as a synonym for ***Mtengo*** is 'root'. The true Chewa term is ***Mezu*** (plural ***Mizu)*** but I rarely heard this term used in the area where I did my research; the concept ***Mtsitsi*** was employed instead. It is difficult for us to understand or feel the significance that roots have for the Chewa. Although I am stressing the importance of utility in Chewa classifications I am not denying that they do not have an interest in plant morphology and structure—indeed they do—but this interest if focused to a large extent on leaves and roots. In asking what uses of specific plants were ***(Ntchito ciani?)*** the immediate response often was "You dig down" ***(Mukumba Pansi)***, and you were expected to realize the implications, i.e. that it had medicinal value as ***Mankhwala***. Many times I have observed herbalists digging up roots to check or confirm the identification of a plant, and one woman to whom I showed a specimen (an *Albuca* lily) said to me "Bring me more leaves and the *root* and I'll tell you what it is!"

Many herbalists, in particular, have an amazing propensity for identifying plants by their roots. This is because many of the plants that are of crucial importance to the Chewa are neither trees, nor do they have conspicuous flowers; it is their utility as food or medicines that give them salience. Several members of the plant families *Vitaceae*, *Asclepiadaceae* and *Menispermacceae* are examples. Incidentally, the old Greek herbalists were called *Rhizotomoki*, the root gatherers.[6]

It is important, then, to realize that there are no concepts in Chewa which correspond to the broad morphological divisions of 'tree', 'shrub', 'herb' (noted by Theophrastus, [Hort 1968]) or 'vine' (cf. Berlin et al 1974:373). There are terms which are sometimes glossed as "shrub" or "bush" such as ***Chitsamba (Tsamba***, leaf) or ***Chipfutu***. Essentially these refer to the shrubby or tufted growth of either grasses or trees, on their regeneration after being cut back or burned and not to shrubs as such. The term ***Chilambi*** (Yao ***Chisirisya)***– ***Cissampelos Mucronata*** is prototypical—is also used to cover several creepers, and like the term ***Mtsitsi***, appears to mean, in some contexts, 'vine' or 'creeper'. However, cultivated vines and plants such as the creeper *Mondia Whytei* because they are not used as cordage, are not considered 'vines' at all, although they ought to be on morphological grounds. Equally important is the fact that bamboos, bananas and many cultivated plants are considered outside (unaffiliated) to the two main categories. Thus millet, maize and sorghum are not ***Mandzu***, although, again, they ought to be by morphological criteria, and indeed the pearl millet ***Machewere*** belongs to the same genus *Pennisetum* as does the grass ***Nsenjere***. This division largely reflects what we have already noted, namely the important symbolic categorization in Chewa between the village and the woodland, and both ***Mtengo*** and ***Maudzu*** essentially refer to useful plants that are to be found in the woodland.

Although there is a pragmatic emphasis at both the life-form and generic levels of Chewa classifications there are also a number of intermediate categories that have a largely functional significance. I have already mentioned ***Mwanawamphero***. Three other taxa are worth noting: (1) ***Thelele*** is a grouping of plants used in the preparation of a kind of mucilaginous relish, referred to by the same term. It is focused around the semi-cultivated *Hibiscus acetosella*. Other species in this category are, in addition, referred to by monotypic generic terms, such as ***Denje*** *(Corchorus trilocularis)* and ***Chewe*** *(Sesamum angolense)*. (2) ***Mtibulo***, although probably of Yao derivation, this is a category that is widely applied to plants that are used by men as a potency medicine. The category is focused on the creeper *Mondia whytei*. (3) ***Mpira*** is usually translated as rubber, but it is employed as a taxonomic category for many latex-bearing plants like *Landolphia kirkii* and *Euphorbia geniculata*. Whether one considers these as generic or intermediate categories seems unimportant: what is essential to understand is that these taxa have both a functional and a taxonomic significance for the Chewa. And each of these categories—indeed almost all categories for the Chewa—have a prototypical member which virtually defines the class; for instance, *Hibiscus acetosella* is described as ***Thelele Yeni-Yeni*** (truly this plant) (cf. Berlin et al 1974:34, Bulmer 1979:58).

To further stress the close relationship between utility and classification I now outline, in some detail, the Chewa classification of fungi, a category that tends to be overlooked by cognitive anthropologists.

CLASSIFICATION OF FUNGI *(Bowa)*[7]

Around 500 species of the larger fungi have been described from the Shire Highlands of Malawi (Morris 1983). Around 14 percent (70) of these are known to have cultural significance for the Chewa. With the exception of two taxa, all are categorized as ***Bowa*** and are considered edible. Although it may be possible to speak of ***Bowa***, like the English term mushroom, as a general concept for the larger fungi, in Chewa it essentially refers only to edible species. Edibility is a defining characteristic of the taxon, and in everyday usage inedible and poisonous fungi are *not* considered ***Bowa***. Any of the latter species when categorized at all, for they have no generic name, are usually referred to as ***Chirombo***. This category, as we have noted, is complex; it essentially refers to any organism that is useless or harmful to mankind.

I have heard it suggested that the term ***Chirombo*** is not applicable to fungi or plants, but almost everyone I knew who collected fungi made a clear categorization between edible fungi or ***Bowa***, and inedible species which were described as ***Chirombo***. "It is not a ***Bowa*** but a useless thing ***(Chirombo)***" was an expression that women often used. Interestingly, several species which are in fact edible, but which are not eaten (as far as I could ascertain) in Malawi have no common name. Examples are *Agaricus silvaticus*, and, in the Zomba district at least, *Suillus granulatus*.

In an early report on local foods Williamson (1941:12) mentions that in the classification of fungi "each district seems to have its own distinct set of names." This is true, and what is significant is that not only is there wide agreement about common names within a specific locality, but there seems to be a common pattern of categorizing fungi throughout Malawi. The basic schema is denoted as follows:

FUNGI

BOWA
(See Table Two)

CHIROMBO

FODYA WA NYANI
(LYCOPERDON CITRINUM)

NGOMA WA NYANI
(CALVATIA UTRIFORMIS)

No specific names in the folk taxonomy: it includes inedible and poisonous fungi such as –

AFROBOLETUS LUTEOLUS
AMANITA MUSCARIA

HYPHOLOMA SUBVIRIDE
LECCINUM UMBONATUM
XEROCOMUS PALLIDOPORUS

ETHNOMYCOLOGY OF THE CHEWA

Most women in rural areas have an extensive knowledge of the identification and ecology of fungi. Although I recorded about seventy edible species, because of their varied geographical distribution, few women knew all of them. Most female informants could name, without difficulty, about 20 species. Knowledge about fungi, as with other wild vegetable foods, is largely confined to women, and there were few men who knew anything about fungi, except for the commoner species, which they normally referred to simply as *Bowa*. I asked the president of a herbalist association, a man with a deep and impressive knowledge of medicinal plants, what edible fungi he knew. He named four, and after a few minutes of thought, admitted that he could remember no more. This variability in folk knowledge according to age, sex, class or ritual affiliations tends to be overlooked in some discussions of folk classifications (cf. Hays 1976:491).

Although there is a broad correspondence between folk terms and scientific nomenclature, several names are applied to species of quite diverse scientific genera. The grounds for doing so may be ecological. For example, many mushrooms are associated with the ***Msuku*** tree, *(Uapaca kirkiana)* and these bear names that indicate the association, ***Kamsuka***, ***Nakasuku***, ***Ngunda Suku*** (Pipe of the ***Msuku***). Thus certain edible species of *Lactarius* are put in the same category as *Cantharellus*, although local people do not confuse them, for they usually treat the latex-bearing *Lactarius* to a more elaborate cooking procedure. Likewise the two species of *Lentinus* share the same term as the Bolete *Gyroporus Luteopurpureus*, ***Kamchbikuni (Nkhuni***, firewood), as all grow on or near dead timber.

Other groupings are based on texture or appearance. ***Kanchombo*** is a term derived from ***Mchombo***, the navel, and is indicative of a pointed or unbonate cap. It is specifically applied to *Termitomyces eurrhizus* whose sharply pointed cap enables the fungus to push its way through the termite mound. But it is also applied to two common species of *Psathyrella*, one of which significantly bears the specific name ***Atroumbonata*** (*Atro*. dark, ***Umbilicus***, navel). The mycologist, Pegler is clearly thinking along the same lines as the Chewa. Another widely used term is ***Msongolo wa Nkhwali***—"the lower leg of the

Francolin". This has been noted with reference to a number of very different fungi – *Cantharellus tenuis* and *Melanoleuca Melaleuca* for example, and alludes to the reddish color of the cap, which is reminiscent of the red legs of this common game bird.[8]

Like all good mycologists, Chewa women do not put much stress on color, but when handling and identifying fungi rely more on smell and texture. When discussing my specimens with women, I found great difficulty curbing their natural tendency to tear the fungus apart, as they always do in verifying the identification of a particular species. If one asks a woman to group a collection of fungi they invariably place the important species into two categories. Into one category they place *Russia schizoderma*, all the *Cantharellus* and *Termitomyces schimperi;* into the other they put the three main species of *Amanita*, and *Termitomyces eurrhizus.* If one asks about the rationale behind this 'covert' categorization it is suggested that the second grouping consists of those ***Bowa*** which have a slippery texture– ***"Onse Lutelele"***. This is in accord with the folk classifications, for the taxon *Katelela* is virtually a generic term for the edible *Amanita*. Again this links with an important functional category within the ***Mtengo*** life-form, ***Thelele*** (discussed earlier).

Folk generics (see Table 2) can be roughly divided into two types: simple generics like ***Manyame***, ***Nakajeti*** and ***Nyonzwe***, and those which have metaphoric connotations, such as ***Ngoma wa Nyani***, ("Drum of the Baboon"), ***Mpafa ya Fulu***, ("Liver of the Tortoise") are examples. But significantly, this division corresponds to the cultural importance of the fungi; all those generic terms which are metaphorical are of secondary importance as a food source, or like ***Fodya wa Nyani***, Baboon's Tobacco *(Lycoperdon citrinum)* are considered inedible.

Finally, it is worth noting that Chewa Women see a much closer association between mushrooms and meat ***(Nyama)*** than between fungi and either plants or vegetables. One woman categorized a basket of fungi by dividing them always into two piles, ***Nyama*** (edible) and ***Chirombo*** (inedible fungi). She used the term ***Nyama*** almost as a taxonomic category for the edible species. This association of fungi with animal life, rather than with plants ***(Mtengo)***, based as it is on texture and edibility rather than morphology, is probably widespread in traditional cultures. Gerard described fungi as "meates", and the tissue of fungi is normally spoken of by analogy as flesh (cf. The writings of Theophrastus in Hort 1968:21). One anthropologist, writing of the Semai people of Malaysia, suggests that fleshy fungi are indeed grouped with animals as 'real' food (Dentan 1968: 34-35). The Chewa clearly see ***Mtengo*** and ***Bowa*** as quite distinct categories, and the general notion, accepted by Europeans and many past biologists, that all living things belong to one of two kingdoms, plants and animals (with 'fungi' placed in the 'plant' category) makes little sense to the majority of Chewa women. To suggest to a Chewa that a particular fungus belongs to the ***Mtengo*** category is rather like asking an English person whether a cabbage was a kind of tree. Thus the views of Chewa women are probably closer to those of the modern taxonomist than the ideas of the great botanist Linnaeus.

CONCLUSIONS

I have given above a broad outline of Chewa folk classification, and specifically the classification of fungi ***(Bowa)***. In the light of this discussion some broad conclusions can be made.

Firstly, although ethnoscience was motivated by a genuine desire to present the cognitive principles of a particular culture (and Sturtevant (1964) indeed defined ethnobotany as a "specific cultural conception of the plant world") an undue focus was put on morphology and classification. But folk taxonomic hierarchies are relatively shallow, and the term hierarchy is almost a misnomer when one considers, for instance, that about 20 percent of Tzeltal plant categories are unaffiliated to any life-form taxa, and that some

TABLE 2.—*Chewa classification of the Taxon Bowa*

		Cantharellus cibarius	CHIPATWE WAYERA NAFUWANKHUKU NGUNDASUKU
MANYAMA CHIPATWE (Y)		Cantharellus congolensis	CHIPATWE CHAKUDA NAKAMBUZI MAKUNGUTA (Y)
		Cantharellus longiporus	CHIPATWE WAFIRA NGUNDASUKU ANAKSUKU
		Cantharellus densifolius	NGUNDASUKU WAYERA
	MSONGOLO WANKHWALI	Catharellus tenuis	
		Melanoleuca melaleuca	KASANJALA KANJALA
		Lactarius gymnocarpus	KUNGULUKWETITI KAMSUKU NKWICHI
	NAKASUKU		
		Lactarius sp. JW 563	KAMBWALO KAMPHANDE
		Lactarius sp. BM 131	NGUNDASUKU
		Lactarius vellereus	
		Russula schizoderma	
CHIPINDI		Russula sp. JW 578	LILANGWI USINDA (Y) MKADZADZULO
		Russula sp. JW 593	
		Russula sp. JW 580	NAMALOBA
		Russula cyanoxantha	TERENYA WAFIRA
TERENYA			
		Russula ochroleuca	TERENYA WAYERA

TABLE 2.—*Chewa classification of the Taxon Bowa* (continued)

		Macrolepiota diolichaula NAMANDADERENGWA
	UTENGA (Y) TAMBALA	Amanita hemibapha KALONGONDWA KATSOBOLA NDEZA
NDELEMA KATELELA		Amanita rhodophylla
		Amanita zambiana SANDJI
		Amanita bingensis NAKAJONGOLO MSONGOLO WANKHWALI
		Aminita elegans BONGOLOLO NAKATOTOSI (Y) KATALESYA (Y)
		Amanita rubescens
NGODZI NAKAJETI (Y)		Amanita goossensiae MUSENDAIWA
		Amanita sp. JW 595
		Lepiota sp. JW 585 NKOTWE
		Gyroporus luteopurpureus
KAMCHIKUNI		Lentinus cladopus Lentinus squarrosulus KAMSEMPHA CHINTSEMPHA NAKATASI (Y)
		Phlebopus colossus NGOMA WANYANI
MPAFA YAFULU MPHAMFA		Russula nigricans Phaeogyroporus portentosus Pulveroboletus aberrans Suillus granulatus Xerocomus soyeri
KALISACHI		Schizophyllum commune
		Clavaria cfr albiramea KABVISAZA KASANZA MUSANJALA NAKAMBI (Y)

TABLE 2.—*Chewa classification of the Taxon Bowa* (continued)

			Termitomyces robusta	
			Termitomyces eurrhizus	
				KACHOFU
				NAKATERESYA (Y)
				UTEMBO (Y)
				UWUMBU
				MAZUMBUKIRA
				KAMBVI
NTHANDO				
	KANCHOMBO		Termitomyces microcarpus	
				MANDA
		UJONJO		
		NYONZWE	Termitomyces clypeatus	
				NAKASUGULI
			Micropsalliota brunneosperma	
			Psathyrella atroumbonata	
			Psathyrella candolleana	
			Mycena sp. JW 697	
				CHAMASALA
			Termitomyces schimperi	
				NYONZWE WANKULU
				USINDA WANKULU (Y)
				LILANGWI
				MANANDARENGWA
				MAZUMBUKIRA
				NAKASOWU (Y)

Unaffiliated taxa

KASALE	Termitomyces striatus
CHANJIRA UPYA	Termitomyces aurantiacus
NAKATERESYA	
UTALE	Termitomyces nr titanicus
BAMBOMULUZA	
KATSOKOMOLE	
NGUNDA NGULUWE	Xerocomus pallidoporus
MPANDO WAFISI	Strobilomyces costatispora
FISI	
KASANGA	Gyroporus castaneus
KADYA M'LERO	Lactarius sp. JW 581
CHING 'AMBE	
NYAME	
BOWA WAFIRA	Russula lepida
KAFIDI	Russula atropurpurea
KAMWAZI	
MKODZO WAGARU	
KAMTHOVA	Russula delica

TABLE 2.–*Chewa classification of the Taxon Bowa* (continued)

DEGADEGA	Amanita baccata
KACHITOSI	Amanita nr calopus
BONGOLOLO	Amanita vaginata
PEZUPEZU	Amanita fulva
CHADWALI	Oudenmansiella radicata
NKALANGANJI	Serulina lachnocephala
KANJADZA	Stereopsis hiscens
KANYAMA	Cymatoderma dendriticum
ULANDI (Y)	Inocybe sp. BM 74
NKOLAKOLA	Agaricus campestris
MSOLO WANKHWALI	Agaricus sp. JW 571
MATWE	Auricularia auricula
MAKUTUKUTU	
KHUTULANJOBVU	
MANGUNGULI	Collybia dryophila
KWASANGA	Collybia sp. JW 662

85 percent of the generics are monotypic. When Friedberg (1979:85) suggests that plants in Bunaq taxonomy appear to be classified more according to a "complex" web of resemblances" rather than forming a neat hierarchy, she would seem closer to the ethnographic reality. Moreover, to suggest as do some ethnoscientists, that "a culture itself amounts to the sum of a given society's folk classifications" (Sturtevant 1964:100) or that "natural phenomena may be said to be culturally relevant simply by virtue of their existence" (Hunn 1977) is to state both too little and too much. In the former regard, folk knowledge extends well beyond what is encapsulated in formal taxonomies, and many Chewa-speakers knew the medicinal properties of plants for which they could not give a name, for much knowledge is memorate or unformalized. In the latter regard, to suggest that classification extends well beyond what has immediate utility, and that plants and animals have salience simply because they happen to be there within the human life-space, because "curiosity as well as hunger is a basic human drive" is to go to the opposite extreme.[9]

The Chewa do not "see", let alone know and classify most of the fungi which are to be found in their immediate environment, and the same might be said of most human communities. In addition Chewa folk concepts do not constitute logical or inclusive categories, for their folk classifications are inherently flexible, with many ambiguous or overlapping categories. While they do have a deep interest in the naming and categorization of plants (and in this they contrast significantly with the Hill Pandaram) their classifications largely focus *around* prototypical taxa. Hallpike's suggestion (1979:169-235) that folk classifications are inherently complexive rather than hierarchic, and dominated by concrete associations and "functional entailment" are certainly confirmed by my own studies.

Secondly, although we can accept that there is no necessary one-to-one relationship between utility and nomenclature,[10] nevertheless it is important to recognize that functional criteria are intrinsically linked to taxonomic ordering. As I have tried to indicate above, many Chewa life-form categories cannot be understood in purely morphological terms, and functional categories like ***Mwana wa Mpbepo*** also have a taxonomic relevance. Ethnoscientists have recognised that cultural significance has salience in the differentiation of folk generics (Berlin et al 1974:99, Berlin 1976:392-4) and they have recognized too that functional categories exist although these are seen rather misleadingly as non-taxonomic groupings (cf. Hays 1979:257). But a true understanding of the nature of folk classifications, both in a culturally specific context and in terms of the evolution–the "encoding sequence"–of life-form categories demands that we incorporate into the analysis functional criteria. As anthropologists we should be concerned with systematically exploring the relationship between folk classifications and other aspects of cultural life. To view folk taxonomies simply as taxonomies, abstracted from utilitarian, ecological and cultural concerns, limits our understanding of how human groups related to the natural world.

LITERATURE CITED

BERLIN, BRENT, D. E. BREEDLOVE and P.H. RAVEN. 1968. Covert categories and folk taxonomies. Amer. Anthr. 70: 290-99.

________. 1974. Principles of tzeltal plant classification. Academic Press, New York.

BERLIN, BRENT. 1974. Further notes on Covert Categories and Folk Taxonomies. Amer. Anthr. 76:327-331.

________. 1976. The concept of rank in ethnobiological classification: some evidence from aguaruna folk botany. Amer. Ethnol. 3:381-99.

BINNS, BLODWEN. 1972. Dictionary of plant names in Malawi. Govn. Print. Zomba.

BROKENSHA, DAVID and W. RILEY BERNARD. 1980. Mbeere knowledge of their vegetation and its relevance for development. Pp. 113-129 *in* David Brokensha, D.M. Warren and Oswald Werner, Indigeous Knowledge Systems and Development. Univ. Press of America, Lanham, North Dakota.

BROWN, CECIL H. 1974. Unique beginners and covert categories in folk biological taxonomies. Amer. Anthr. 76:325-327.

________. 1977. Folk botanical life forms: their universality and growth. Amer. Anthr. 79:317-342.

________. 1979a. Folk Zoological life-forms: their universality and growth. Amer. Anthr. 81:791-817.

________. 1979b. Growth and development of folk botanical life forms in the Mayan language family. Amer. Ethnol. 6:366-385.

BULMER, RALPH. 1974. Folk Biology in the New Guinea Highlands, Soc. Sc. Inform. 13:9-28.

________. 1979. Mystical and mundane in Kalam classification of birds, Pp. 57-79 *in* Roy F. Ellen and David Reason Classifications in their social context. Academic Press, New York.

CARRINGTON, J. F. 1981. Linguistic pitfalls in Upper Zairean folk taxonomy research. Unpubl. Mss. Nat. Univ. Zaire.

DENTAN, ROBERT K. 1968. The Semai, Holt, Rinehart, New York.

EVANS-PRITCHARD, E. E. 1937. Withcraft, Oracles and Magic amongst the Azande, Clarendon Press, Oxford.

FOLEY, DANIEL J. 1974. Herbs for use and for delight. Dover Publ., New York.

FRIEDBERG, CLAUDINE. 1979. Socially significant plant species and their taxonomic position among the Bunaq of Central Timor, Pp. 81-100 *in* Roy F. Ellen and R. David Rason. Classification in their social context. Academic Press, New York.

HALLPIKE, C. R. 1979. The foundations of primitive though. Clarendon Press, Oxford.

HARGREAVES, BRUCE J. 1976. Killing and curing: succulent use in Chitipa. Cactus and Succulent J. 48:190-196.

HAYS, TERENCE E. 1976. An empirical method for the identification of covert categories in ethnobiology. Amer. Ethnol. 3:489-507.

________. 1979. Plant classification and nomenclature in Ndumba, Papua, New Guinea Highlands. Ethnology 18:253-270.

HOEG, OVE A. 1983. Country People in Norway and their knowledge of Plants. Paper delivered at Plants in Folklore Conference, Univ. Sussex, April 1983.

HORT, ARTHUR. 1968. Theophrastus: Enquiry into plants. Heinemann, London.

HUNN, EUGENE S. 1977. Tzeltal folk zoology: the classification of discontinuities in nature. Academic Press, New York.

________. 1982. The Utilitarian Factor in Folk Biological Classification. Amer. Anthrop. 84:830-847.

LEVI-STRAUSS, C. 1966. The Savage Mind. Weidenfeld and Nicolson, London.

LITERATURE CITED (continued)

______. 1969. Totemism. Penguin Books, Harmondsworth.

______. 1972. Structural Anthropology. Penguin Books, Harmondsworth.

MALINOWSKI, B. 1974. Magic, science and religion. Souvenir Press, London. Reprint of 1925 edition.

MITCHELL, J. C. 1956. The Yao Village. Manchester Univ. Press, Manchester.

MORRIS, BRIAN. 1962. A denizen of the evergreen forest. African Wildlife 16:117-121.

______. 1964. Mammals of Zoa Estate, Cholo, Nyasaland J. 17:71-78.

______. 1967. Wild flowers of Mlanje Mountain. African Wildlife 21:71-77, 152-157.

______. 1970. The Orchids of Malawi. Society of Malawi.

______. 1976. Whither the Savage Mind? Notes on the natural taxonomies of a hunting and gathering people. Man (NS) 11:542-547.

______. 1980. Folk Classifications. Nyala 6:83-93.

______. 1983. The Macrofungi of Malawi. Unpubl. Mss. on deposit with author.

NGUBANE, HARRIET. 1977. Body and Mind in Zulu Medicine. Academic Press, London.

RICHARDS, AUDREY I. 1969. Land, labour and diet in Northern Rhodesia (1939). Oxford Univ. Press.

SCHOFFELEERS, J. M. 1968. Symbolic and social aspects of spirit worship among the Mang'anja. Unpubl. Ph.D. Thesis, Oxford Univ.

STRATHERN, MARILYN. 1980. No nature, no culture: The Hagen Case, Pp. 174-222 *in* C.P. MacCormack and M. Strathern Nature, Culture and Gender. Cambridge Univ. Press.

STURTEVANT, W. C. 1964. Studies in Ethnoscience. Amer. Anthr. Pp. 39-61 *in* J. W. Berry and P. R. Dasen (eds.) Culture and Cognition (1974) Methuen, London.

TAMBIAH, S. J. 1969. Animals are good to think and good to prohibit. Ethnology 8: 424-459.

TURNER, VICTOR. 1967. The forest of symbols. Cornell Univ. Press, Ithaca, New York.

WILLIAMSON, JESSIE. 1941. Nyasaland native foods. Nyasaland Times.

______. 1975. Useful plants of Malawi. Univ. Malawi, Zomba.

WITKOWSKI, STANLEY R. and CECIL H. BROWN. 1978. Lexical Universals Ann. Rev. Anthr. 7:427-51.

WITKOWSKI, STANLEY R., CECIL H. BROWN and PAUL K. CHASE. 1981. Where do tree terms come from? Man (NS) 16:1-14.

NOTES

1. Ethnobotanical research in Malawi was undertaken during the year 1979-80 and was supported by an SSRC grant for which I am grateful. My own ethnobiological researches in Malawi go back more than twenty years, for during seven years' residence in the Thyolo and Mulanje districts (1958-65) I collected a lot of data on the folk names and cultural uses of plants and small mammals. (cf. Morris 1962, 1964, 1967). I am thus fairly fluent in Chichewa. During my year's residence I became a student 'novitiate' to several ***asinganga*** (doctor-diviners) and market herbalists, and altogether I worked closely with about twenty-five informant friends, ten of whom were women. In the drafting of the present paper I am appreciative of the help given by Willard Van Asdall and Pat Caplan.

2. It is beyond the scope of this present paper to offer ethnographic material on the wider culture of the peasant communities of Malawi. For some useful background material on the Yao and Chewa-speaking peoples cf Mitchell 1956, Schoffeleers 1968.

3. Tambiah's (1969) interesting discussion of animal categories in Thailand notes that chickens and ducks are not considered to be birds ***(Nog)***, and that many categories are almost defined in terms of edibility.

NOTES (continued)

4. How these ethnographic facts fit into the encoding sequence in the evolution of zoological life forms, as postulated by Cecil Brown and his associates (Witkowski and Brown 1978:437-8, Brown 1979a) it is difficult to assess. But clearly ***Nyama*** is a life-form category of the same taxonomic status as ***Njoka*** and ***Mbalame*** (under no circumstances would ***Njoka*** be described as a kind of ***Nyama)***, and it is defined by cultural criteria for which Brown's perspective finds no place, at least in his discussion of animal categories. Moreover, to situate 'animal' beyond or outside the schema obscures some interesting developments that have occurred in the evolution folk taxonomies, and the shift of focus from utility to morphology.

5. The polysemous nature of plant categories is widespread (cf Richards 1969:232, Bulmer 1974: 20, Ngubane 1977:22). In a recent paper, Witkowski and his associates (1981) note that the wood/tree polysemy is found in a variety of languages. Whether the loss of this polysemy is *directly* linked to increased societal complexity is difficult to say, for a hunter-gathering community like the Hill Pandaram has three morphological categories–***Maram*** (trees and woody plants), ***Valli*** (creepers and lianas) and ***Chedi*** (ferns and herbaceous plants) (Morris 1976:546), that are very similar to those described elsewhere (cf. Berlin et al 1974, Berlin 1976:385, Hays 1979) while a much more technologically complex society like the Yao has but two life forms (excluding the fungi), the primary category ***Mtera***, which like the Chewa ***Mtengo***, is polysemous and extremely wide in scope. Brown's study of the development of Mayan botanical life-forms (1979) indicates that almost all life-form categories derive initially from functional polysemous concepts, and yet, surprisingly, in an earlier paper (1977:320) he appears to *define* these categories as non-functional.

6. The Anglo-Saxon word "wort" originally meant 'root', and was used to designated many plants that has medicinal properties. Many English plant names still carry the term, e.g., St. John's Wort, Figwort, Mugwort, Ragwort. It has been suggested that it was a virtual synonym for "herb", a concept that did not originally refer to small herbaceous plants, i.e., it was not a morphological category at all, but to any plant that had utility as medicine or for culinary purposes (Foley 1974:187). Many common herbs, of course, are shrubs (Dogrose), trees (Wych Hazel) or climbers (Nightshade). Early English folk classifications also seem, therefore, to have a functional bias. In an interesting paper, Hoeg (1983) has described how country people in Norway are able to identify ferns by the feel of their rhizomes, and in Gerard's classic 'Herbal' (1597) the illustrations of the plants all show the structure of the roots, sometimes, as with the common arum, without the flowers.

7. With respect to the present paper I should particularly like to express my thanks to Chenitta Selemani and her sister Esmie, Benson Zuwani, Kitty Kunamano, Rosebey Mponda and Salimu Chinyangala for help and instruction on those aspects of Malawi cultural life relating to *bowa*. During the year–and in a subsequent short visit–I made water-color sketches, and collected data and specimens of over five hundred fungi. The specimens are deposited in herbaria located at Kew and Zomba. Material for this paper is based on these collections, and draws on my larger study on the Macrofungi of Malawi (in press). For the identification of my specimens I am grateful to Dr. David Pegler of the Herbarium, Royal Botanical Garden, Kew, England.

8. Importantly when categorizing and describing fungi reference is continually made to the three 'primary' colors, names - *era*, light or white, *-da*, dark or black, and - *fira*, covering all the fiery colours as well as yellow. These are basic to the Chewa and have important symbolic connotations.

9. In a recent paper, Hunn (1982) has modified his earlier views and has, like myself, although in a more substantive theoretical manner, come to stress the 'utilitarian factor' in folk classifications.

10. In a more recent study of the Aguaruna Indians of Peru, Berlin (1976:393) suggests that about one third of the plants known to these people are conceptually recognized but lack cultural importance.

J. Ethnobiol. 4(1):61-72 May 1984

PROTEIN CONTENT OF SOME EDIBLE INSECTS IN MEXICO

JULIETA RAMOS ELORDUY de CONCONI
JOSE MANUEL PINO MORENO
CARLOS MARQUEZ MAYAUDON
Instituto de Biología, Universidad Nacional Autónoma de México
Apartado Postal 70-153, México, D.F. 04510

FERNANDO RINCON VALDEZ
MANUEL ALVARADO PEREZ
ESTEBAN ESCAMILLA PRADO
Escuela Superior de Agricultura "Hermanos Escobar"
Cuidad Juárez, Chihuahua, México

HECTOR BOURGES RODRIGUEZ
Instituto Nacional de la Nutrición "Salvador Zubirán"
Mexico, D.F.

ABSTRACT.–Of the 101 species of edible insects collected and studied in several Mexican states, 77 were analyzed for protein content and evaluated for protein quality. Percent protein varied from a low of about 10% to a high value of slightly over 81%. For many species of insects, protein quality, as evaluated by aminoacid profiles, compared favorably with those recommended for nutritional purposes by FAO/OMS. It is suggested that with appropriate technology and consumer acceptance, commercially produced insect food products would help alleviate hunger and malnutrition.

INTRODUCTION

Entomophagy, the consumption of insects by humans, has long been known, especially in regions where environmental conditions are often adverse (Ancona 1931, 1932, 1934; Blasquez 1870; Bodenheimer 1951; Conconi and Pino 1979; Figueroa 1968; Hoffman 1947; Lapp and Rohmer 1937; Ruddle 1973; Skinner 1910; Thompson 1954; Tihon 1946; Wallace 1852). In fact, in some areas they are a major food source and are even dried and stored in large quantities for consumption when food is scarce. Considering that in some regions different species of insects are available for consumption in different seasons and since the eggs, larvae, nymphs, pupae (grubs), and adults of, for example, butterflies, moths, bugs, flies, ants, bees, beetles, termites, grasshoppers, and dragonflies, are often eaten, a large number of different species of insects are consumed by humans on a worldwide basis.

That hunger and malnutrition is a problem in human populations in many parts of the world is well known. In some instances the problem may not be a sufficient supply of calories but a deficiency of high quality protein. And so the search for new food sources, including the identification and development of localized ethnic ones, continues.

In Latin America food resources are becoming increasingly scarce and the importing of foods is becoming more expensive. It is thus imperative to identify and develop indigenous food resources. In this report of preliminary research we have turned our attention to insects not only because of their abundance, biomass, and high quality protein, but also because of the time honored practice among many culturally diverse peoples of Latin America of consuming live, roasted, and fried insects, providing them with a nutritious protein source.

MATERIALS AND METHODS

Collection and identification.—The insects for which nutritional studies were conducted in this report were collected during field work in various parts of Mexico where people regularly use them as food. The stage of the insect life cycle which was eaten was noted in every case. A portion of the collection was preserved in acetone for later chemical analysis and the remainder was placed in alcohol for later taxonomic identification and as vouchers.

All specimens were identified at the Laboratory of Entomology, Institute of Biology, The National University of Mexico (U.N.A.M.) in Mexico City, through the use of the taxonomic literature and reference collections.

Chemical and nutritional analyses.—Aminograms were prepared by the Department of Nutrition Physiology of the "Salvador Zubiran" National Institute of Nutrition of Mexico. All other analyses were performed at the Laboratory of Nutrition and Biochemistry of the Veterinary Faculty of U.N.A.M.

Protein content was determined by the Kjeldahl method (Pearson 1970), with the results calculated on a dry weight basis. Aminoacids were measured with an aminoacid analyzer (Beckman CL 119) with the aid of a minicomputer (Beckman model 126 Data System) designed to integrate peak areas of chromatograms. Tryptophan measurements were obtained by the Spies and Chamber (1949) method. Aminoacid profiles were compared to those recommended by FAO/OMS (Patron 1973), and a "chemical score" of aminoacid profiles based on 100% was devised to give us an index of protein quality.

Trejo et al. (1974) interviewed scientists, chefs, and consumers in Mexico City to determine the acceptability of commercially produced insect food products.

RESULTS AND DISCUSSION

Conconi and Bourges (1977) reported in that year that 491 species of edible insects had been recorded on a worldwide basis. During our research in Mexico we recorded 101 species, eaten at various stages of development depending upon the species. These belonged to 31 families in nine orders and included dragonflies, grasshoppers, bugs, lice, treehoppers, cicadas, caddishflies, butterflies, moths, flies, ants, bees, and wasps (Appendix 1). The number of edible species per order varies from 30 in the Hymenoptera (mostly wasps) to only one in the Anoplura (lice). A couple of interesting facts, not apparent in Appendix 1, deserve special comment: eggs are the stage consumed in the aquatic bugs (Corixidae, Notonectidae, and Belostomatidae), and two of the three species of edible Diptera are flies of alkaline lakes.

Protein content, expressed as grams of protein per 100 g of sample, for the 77 species of insects we analyzed, is shown in Appendix II. The data is straight forward and one can readily note the range in nutritional values within and between insect taxa. It is worth highlighting, though, that protein values varied from a low of about 10% for two species of ants to a high of slightly over 81% for the wasp, *Polybia sp*. By way of summary, seven species in the low range had about 29% protein, 19 species fell within the range of 60% to 69%, 11 species from 70% to 77%, and one species had over 81% protein.

Several incidental but nonetheless interesting facts seem worth comment. Two species of butterfly in the family Helialidae utilize *Arbutus glandulosa* as a host tree and they exhibit the lowest (34.34%) protein values and the highest (71.60%) in that family. These values are for *Hylesia frigida* and *Eucheria socialis*, respectively. In the Hemiptera the highest value is for the eggs of several bugs (71.52%), known as "ahuahutle" or Mexican caviar.

Protein quality, as related to human nutrition, is dependent upon the amino acid composition of the source, and we devised a chemical score (Table 1) from aminoacid profiles to facilitate comparisons (see Methods). As noted, our profiles were compared to those recommended (for nutritional purposes) by FAO/OMS (Patron 1973). In general, values for Mexican edible insects obtained for the amino acids isoleucine, leucine, lycine, threonine, valine, phenylalanine and tyrosine surpass the recommendation by FAO. Some Mexican insects, however, had lower values for methionine, cysteine and tryptophan than those recommended by FAO/OMS. The highest score for Mexican insects was found in immature queens of *Liometopum apiculatum*, larvae of *Sciphophorus acupunctatus* and adults of *Hoplophorion monograma* (Conconi and Bourges 1977, Table 1).

TABLE 1.–*Chemical score of some edible Mexican insects.*

Atizies taxcoensis	10%	*Sphenarium histrio*	60%
Ephydra hians	42%	*Cossus redtenbachi*	60%
Hylesia frigida	45%	*Atta mexicana*	60%
Parachartegus apicalis	50%	*Sphenarium purpurascens*	65%
Euchistus strennus	56%	*Vespula squamosa*	70%
Boopedon flaviventris	56%	*Brachygastra mellifica*	70%
Sphenarium spp.	56%	*Brachygastra azteca*	70%
Melanoplus mexicanus	56%	*Polybia parvulina*	70%
Trigona sp.	58%	*Liometopum apiculatum*	80%
Musca domestica	58%	*Sciphophorus acupunctatus*	81%
Pachilis gigas	58%	*Hoplophorion monograma*	96%

The conversion efficiency ratio is based on weight gain by the organism per gram of food eaten. For some edible insects this ratio ranges from 2.1:1 to 11.8:1. The average ratio for the edible insects studied is about 4 to 5:1. For comparison, the ratio for chickens is 2.6:1, for beef cattle 10:1, and for sheep 19:1 (Taylor 1975, DuFour 1981). In part this is because insects are poikilotherms and thus do not allocate a large proportion of food in maintaining body temperature.

As early as a decade ago Trejo et al (1974) interviewed 12,300 people (see Methods) concerning the acceptability of commercially produced insect food products and reported that in this survey 93% indicated that developing insects on a commercial scale was a good project considering that insects are, in general, a nutritious, economical, delicious, complete food, and "in the future."

The result of this study and the survey by Trejo and others suggests that with improved technology insects could be a valuable renewable natural resource. The establishment of massive culturing practices could result in the continuous production of a rich new protein source for the diets of people in the not too distant future.

Editor's note.—Although I would have liked a more detailed description of the methods used, I have decided to publish this paper because of the timeliness of the subject and because of its considerable social significance. I recommend that readers who would like details of methods and other procedures contact the senior author.

ACKNOWLEDGEMENTS

We want to express our gratitude to Dr. Robert Bye of Botanical Garden of the Institute of Biology, The National University of Mexico (UNAM) for his help in the translation and suggestions to the manuscript.

LITERATURE CITED

ANCONA, L. H. 1931. Los chilocuiles o gusanitos de la sal de Oaxaca. Ann. Inst. Biol., Univ. Mex. 11:265-277.

———. 1932. Los jumiles de Taxco. Ann. Inst. Biol., Univ. Mex. IV:193-195.

———. 1934. Los gusanitos de maguey. Ann. Inst. Biol., Univ. Mex. V:134-140.

BLASQUEZ, I. 1870. Insectos de maguey. Naturaleza I, 39-46. Mexico.

BODENHEIMER, F. S. 1951. Insects as human food. Junk Publishers, The Hague.

CONCONI, J. R. E. de 1974. Los insectos como una fuente de proteínas en el futuro (proyecto). Reg. Sec. Educ. Publ. 1639/74.

——— y H. BOURGES R. 1977. Valor nutritivo de ciertos insectos comestibles de México y lista de algunos insectos comestibles del mundo. Ann. Inst. Biol., Univ. Nal. Auton. Mex. Ser. Zool., 48:165-186.

——— y J. M. PINO M. 1979. Insectos comestibles del Valle del Mezquital y su valor nutritivo. Ann. Inst. Biol., Univ. Nal. Auton. Mex. Ser. Zool. 50:573-574.

———, PINO, M. J. y O. GONZALEZ. 1981. Digestibilidad in vitro de algunos insectos comestibles en Mexico. Folia Ent. Mex. 49:141-154.

———, H. BOURGES y J. M. PINO M. 1981. Valor nutritivo y calidad de la proteína de tres insectos comestibles de Mexico. Folia Ent. Mex. 48:101-102.

———. de 1982. Los insectos como una fuente de proteínas en el futuro. Ed. Limusa, Mexico. 144 p.

———, H. BOURGES y J. M. PINO. 1982. Life cycle of *Liometopum apiculatum* and *Liometopum occidentale* var. *luctuosum* (Hymenoptera-Formicidae), with reference to their nutritive value as food in worker and reproductive casts. Proc. 9th Congr. Union Study Social Insect. 2th supplement: 1.

———, F. RINCON V., H. BOURGES R., J. M. PINO M., M. ALVARADO y E. ESCAMILLA. 1982. Hymenopteca Aculeata edible in Mexico. Their nutritive value with emphasis in protein quantity and quality. Proc. 9th Congr. Int. Union Study Soc. *In* Supplement: 2.

———, H. BOURGES y J. M. PINO. 1982. Valor nutritivo y calidad de la proteína de algunos insectos comestibles de Mexico. Folia Ent. Mex. 53:111-118.

———, J. M. PINO M. y H. BOURGES R. 1983. Valor nutritivo y calidad de la proteína de algunos insectos comestibles de Mexico, XVIII Congreso Nacional de Entomologia, Resumenes p. 134-135.

DE FOLIART, G. R. 1975. Insects as a source of protein. Bull. Ent. Soc. Amer. 21(3):161-163.

DUFOUR, P. 1981. Insects: a nutritional alternative. Special Edition of Dept. Med. and Public Affairs George Washington University. Medical Center. 104 p.

FIGUEROA, R. F. de M. 1968. Contribucion al conocomiento del valor nutritivo de los insectos comestibles. Tésis prof. E.N.C.B.I.PN. Mex. 24 p.

HOFFMAN, W. E. 1947. Insects as human food. Proc. Ent. Soc. Wash. 49:223-237.

LAPP, C. & J. ROHMER. 1937. Composition et valeur alimentaire du Criquet Pelerin. Bull. Soc. Chim. Biol. Paris 19: 413-416.

PEARSON, D. 1970. The chemical analysis of foods. Six. Ed. J. & A., London.

RUDDLE, K. 1973. The human use of insects. Biotrópica V. (2):94-102.

SKINNER, A. 1910. The use of insects and other invertebrates as foods by North American Indians. J. New York. Ent. Soc. 18:264-267.

SPIES, J. R. and D. C. CHAMBERS. 1949. Chemical determination of tryptophan in proteins Analy. T. chem. 21(10):1249.

TAYLOR, R. 1975. Butterflies in my stomach, Woodbridge Press Publishing Co., California.

THOMPSON, B. P. 1954. Two studies in African nutrition and urban and rural community in northern Rodhesia. The Rhodes Livingston Institute Paper, No. 24, Manchester University Press, Manchester, England.

TIHON, L. 1946. A propõs des termites au pount de vue alimentaire. Bull. Agric. Congo Belge 37:865-868.

TREJO, S. F., GARCIA, A. RUBIO-FLORES. 1974. Investigacion para la introducción de un nuevo producto alimenticio (Insectos). Tesis profesional UNAM, Fac. Cont. y Admon. 126 p.

WALLACE, A. R. 1852. On the insects used for food by the Indians of the Amazon. Trans. Ent. Soc. London 2:241-244.

APPENDIX 1.–*Edible insects in Mexico.*

Order/Family	Species	Stage Consumed	Place Consumed
Odonata (Dragonflies)			
Aeshnidae	*Anax sp.*[1]	nymphs	Sonora
Orthoptera			
Acrididae	*Ochrotettix cer salinus* Burm.		Oaxaca
(Grasshoppers)	*Tropinotus mexicanus* Brunner		Oaxaca
	Osmilia flavolineata De Greer		Oaxaca
	Plectrotettra nobilis Walk		Oaxaca
	Schistocerca paranensis[1] Burm.		Veracruz, Tabasco, Campeche, Yucatan
	Sphenarium spp.[1]		Morelos, Puebla, Oaxaca
	Sphenarium purpurascens Charp.	nymphs	Oaxaca
	Sphenarium histrio[1] Gerst.	adults	Oaxaca, Guerrero
	Sphenarium magnum Marquez		Oaxaca
	Taeniopoda sp.[1]		Morelos
	Trimerotropis sp.[2]		Hidalgo
	Melanoplus sp.		Oaxaca
	Melanoplus mexicanus Sauss		Oaxaca
	Spharagemon aeguale Say.		Michoacan
	Schistocerca sp.		Oaxaca
	Boopedon flaviventris Sauss.		Oaxaca
	Boopedon sp. af. flaviventris Sauss.	nymphs adults	Oaxaca
	Arphia falax Sauss.		Oaxaca
	Encoptolophus herbaceus Sauss.		Oaxaca
Anoplura (Lice)			
Pediculidae	*Pediculus humanus*[1] Linneo	adults	Oaxaca
Hemiptera (Bugs)			
Pentatomidae	*Euchistus crenator*[1] Stal		Morelos, Estado de Mexico, Hidalgo, Veracruz, Guerrero
Common Name ("Jumiles")	*Euchistus lineatus*[1] Walk		Morelos, Estado de Mexico, Hidalgo, Veracruz, Guerrero
	Euchistus strennus[1] = (E. zopilotensis) Distant	nymphs adults	Morelos, Estado de Mexico, Hidalgo, Veracruz, Guerrero
	Edessa mexicana[1] Stal.		Morelos
	Edessa petersii Stal.		Guerrero
	Edessa conspersa Stal.		Estado de Mexico
	Atizies taxcoensis[1] Ancona		Guerrero
	Atizies sufultus Smith		Guerrero

APPENDIX 1.–*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
Coreidae	*Pachilis gigas*[1] B.	nymphs adults	Queretaro, Guerrero, Hidalgo, Sn. Luis Potosi
Corixidae (Water Bugs)	*Krizousacorixa azteca*[1] Jac.	eggs	Estado de Mexico, Guanajuato, Michoacan
Common name ("ahuahutle" "axayacatl")	*Krizousacorixa femorata*[1] Guerin	nymphs	Estado de Mexico, Guanajuato, Michoacan
	Corisella texcocana[1] Jac.	adults	Estado de Mexico, Guanajuato, Michoacan
	Corisella mercenaria[1] Say		Estado de Mexico, Guanajuato, Michoacan
Notonectidae	*Notonecta unifasciata*[1] Guerin	adults	Estado de Mexico, Guanajuato, Michoacan
Belostomatidae	*Lethocerus sp.*[1]	nymphs	Distrito Federal
	Abedus ovatus[1] Stal.	& adults	Distrito Federal
Homoptera			
Membracidae	*Umbonia reclinata* Germar	adults	Puebla
(Treehoppers)	*Umbonia sp.*	nymphs	Morelos, Guerrero
	Hoplophorion monograma[1] Germar	& adults	Michoacan, Guerrero, Estado de Mexico
Cicadidae (Cicadas)	*Proarna sp.*[2]	adults	Hidalgo
Coleoptera (Beetles)			
Curculionidae	*Metamasius spinolae*[1] Vaurie		Hidalgo
	Rhynocophorus palmarum[1] Linneo		Tabasco, Guerrero, Veracruz
	Sciphophorus acupunctatus G.		Hidalgo, Estado de Mexico, Oaxaca
Scarabaeidae	*Strategus sp.*[1]	larvae	Nayarit, Chiapas
	Phyllophaga spp.[1]		Michoacan
	Xyloryctes spp.[1]		Chiapas
Crysomelidae	*Leptinotarsa decemlineata* Say	larvae	Oaxaca
Histeridae	*Homolepta sp.*	larvae	Oaxaca
Passalidae	*Oileus reinator* Trequi	larvae	Oaxaca
	Passalus af punctiger Lep. y Serv.	larvae	Oaxaca

APPENDIX 1.–*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
Cerambycidae	*Cerambyx sp.*[1]	larvae	Michoacan, Guerrero
	Trichoderes pini[1] Chevr.	larvae	Guerrero, Michoacan
	Stenodontes cer. maxillosus Drury	larvae	Oaxaca
	Aplagiognathus spinosus N.	larvae	Oaxaca
Cicindelidae	*Cicindela curvata*[1] Chevr.	larvae	Chiapas
	Cicindela roseiventris[1] Chevr.	larvae	Chiapas
Trichoptera			
Hydropsichidae	*Leptonema sp.*[1]	larvae	Veracruz
Lepidoptera (Butterflies and Moths)			
Megathymidae	*Aegiale* (Acentrocneme) *hesperiaris*[1] Kirby	larvae	Estado de Mexico, Hidalgo, Tlaxcala, Queretaro, San Luis Potosi, Oaxaca, Jalisco, Distrito Federal.
Geometridae	*Synopsia mexicanaria* Walk	larvae	Distrito Federal
Hepialidae	*Phassus* sp.	larvae	Oaxaca, Puebla
Noctuidae	*Heliothis zea*[1] Boddie	larvae	Puebla, Hidalgo
	Ascalapha odorata[1] Linneo	larvae	Oaxaca, Guerrero
	Spodoptera frugiperda S.	larvae	Estado de Mexico
Cossidae	*Xileutes redtenbachi*[1] Hamm	larvae	Estado de Mexico, Hidalgo, Tlaxacala, Queretaro, Puebla, San Luis Potosi, Oaxaca, Jalisco, Distrito Federal.
Pyralidae	*Laniifera cyclades*[1] Druce	larvae	Hidalgo
Pieridae	*Eucheria socialis*[1] Westwood	larvae	Distrito Federal, Chihuahua, Hidalgo
	Catasticta teutila Doubleday	larvae	Oaxaca
Saturnidae	*Hylesia frigida* Hubner	larvae	Oaxaca
	Arsenura armida Cramer	larvae	Puebla, Oaxaca, Veracruz, Chiapas
Diptera (Flies)			
Ephydridae	*Ephydra (Hydropyrus) hians*[1] (Say) Cresson	larvae	Estado de Mexico
	Gymnopa (Mosilus) tibialis[1] Cresson	larvae	Estado de Mexico
Muscidae	*Musca domestica* Linneo	larvae	Nayarit, Veracruz

APPENDIX 1.–*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
Hymenoptera	*Liometopum occidentale* var. *luctuosum* W.	eggs larvae pupae	Michoacan, Puebla Zacatecas
Formicidae (Ants)	*Liometopum apiculatum*[1] Mayr.	eggs larvae pupae	Estado de Mexico, Hidalgo, Tlaxcala
	Myrmecosistus melliger[1] Llave (Luc)	adults	Tamaulipas, Hidalgo
	Myrmecosistus mexicanus[1] W.		Yucatan, Campeche
	Atta mexicana[1] Bourmeir	adults	Veracrus, Oaxaca, Guanajuato
	Atta cephalotes[1] Latr.		Chiapas, Guerrero
Apidae (Bees)	*Apis mellifica*[1] L.	honey	All Mexican Republic
	Melipona fasciata guerreroenisis[1] Schw.	eggs	Guerrero
	Melipona beeckei[1] Bennet	larvae	Yucatan
	Trigona jaty[1] F.	pupae	Oaxaca, Tabasco, Campeche, Yucatan
	Trigona nigra nigra[1] Cress		Oaxaca, Tabasco, Campeche, Yucatan
	Partamona sp.[1]		Campeche, Yucatan
	Trigona sp.		Oaxaca
	Lestrimelita limao[1] Sm.	eggs pupae larvae	Campeche, Yucatan
Vespidae (Wasps)	*Brachygastra lecheguana*[1] L.	eggs larvae pupae	Michoacan
	Brachygastra mellifica Say	immature stages	Oaxaca
	Polybia spp.	eggs	Oaxaca Michoacan
	Polistes sp.	larvae pupae	Michoacan

APPENDIX 1.—*Edible insects in Mexico* (continued)

Order/Family	Species	Stage Consumed	Place Consumed
	Polybia occidentalis bohemani Holmgren		Oaxaca
	Polybia occidentalis nigratella B.		Oaxaca, Michoacan, Veracruz, Puebla
	Polybia parvulina Richards	immature	Oaxaca
	Brachygastra azteca Sauss	stages	Oaxaca
	Mischocytarus sp.		Oaxaca
	Parachartegus apicalis F.	immature	Oaxaca
	Polistes canadensis L.	stages	Oaxaca
	Polistes major B.		Michoacan
	Anmophila sp.		Oaxaca
	Vespula squamosa Drury		Oaxaca

[1]Conconi, J. R. E. de and H. Bourges, 1977.

[2]Conconi, J. R. E. de and J. M. Pino M., 1979.

APPENDIX 2.–*Protein content of insects, expressed as a percentage of grams of protein per 100 grams of sample on a dry weight basis.*

Species (arranged in orders)	Common Name, Stage Consumed Notes	Percent Protein
Hymenoptera (Ants, Bees, Wasps)		
Myrmecosistus melliger	"hormiga mielera", "honey ant"[2]	9.45%
Myrmecosistus mexicanus	"hormiga mielera", "honey ant"	10.5%
Melipona beeckei	"abeja que no pica"	28.95%
Liometopum apiculatum	"escamol", larvae	37.33%
Liometopum occidentale var. luctuosum	"escamol", adults	37.54%
Liometopum apiculatum	"escamol de obreras"	40.90%
Liometopum occidentale var. luctuosum	"escamol de reproductores"	41.68%
Atta cephalotes	"hormiga arriera"[2]	42.59%
Liometopum apiculatum	"escamol", adults	45.06%
Liometopum apiculatum	"escamol", adults	45.53%
Liometopum occidentale var. luctuosum	"escamol de obreras"	48.28%
Polybia sp.	"avispas" larvae	51.50%
Brachygastra mellifica	"avispas, panal de castilla"	52.84%
Liometopum apiculatum	"escamol", pupae	53.32%
Parachartegus apicalis	"avispa ala blanca"	54.59%
Polistes instabilis	"avispa guitarrilla", pupae	57.75%
Polistes major	"avispa coloradad", pupae	57.93%
Atta mexicana	"hormiga chicatana"[1]	58.3-42.59%
Polistes instabilis	"avispa guitarrilla", larvae	60.00%
Polybia parvulina	"avispa negra"	61.40-58.44%
Polybia occidentalis bohemani	"avispa rayada"	61.57%
Brachygastra azteca	"avispa cola amarilla"	62.74%
Vespula squamosa	"avispa panal de tierra"	62.85%
Polybia occidentalis nigratella	"avispa huevo de toro"	62.93%
Polybia sp.	wasps eggs, larvae, pupae	62.97%
Liometopum apiculatum	"escamol", larvae y pupae	66.90-47.94%
Polistes major	"avispa colorada" larvae	71.99%
Mischocytarus sp.	"avispa negra con franjas"	74.51%
Polybia sp.	"avispa negra"	81.69%
Orthoptera (Grasshoppers,) "chapulines"		
Sphenarium histrio[1]		52.13%
Plectrottetra nobilis		58.31%
Sphenarium histrio		58.31%
Sphenarium purpurascens		58.31%
Melanoplus sp.		58.31%
Sphenarium magnum		59.63%
Sphenarium histrio = bolivari[1]		62.93%
Trimerotropis sp.[2]		65.13%

APPENIX 2.–*Protein content of insects, expressed as a percentage of grams of protein per 100 grams of sample on a dry weight basis.* (continued)

Species (arranged in orders)	Common Name, Stage Consumed Notes	Percent Protein
Sphenarium sp.		69.97%
Taeniopoda sp.		70.92%
Arphia falax		71.35%
Boopedon sp. flaviventris		71.35%
Sphenarium sp.		71.35%
Melanoplus mexicanus		71.35%
Encoptolophus herbaceus		71.35%
Melanoplus femur-rubrum		75.30%
Boopedon flaviventris		77.13%
Sphenarium spp.		77.13%
Melanoplus mexicanus		77.13%
Hemiptera (Bugs)		
Edessa conspersa	"jumiles"	36.82%
Atizies sufultus		44.10%
Edessa mexicana	"jumiles"	44.10%
Euchistus zopilotensis = strennus	"jumiles"	44.10%
Euchistus zopilotensis	"jumiles"[1]	44.67-41.82%
Edessa petersii	"jumiles"	58.56%
Pachilis gigas	"chamoes", nymphs[2]	62.95%
Pachilis gigas	"chamoes", adults[2]	65.39%
Abedus ovatus	"cucarachon de agua"	67.69%
Corisella mercenaria	"axayacatl"[1]	68.70%
Corisella texcocana		69.94-54.44%
Corisella mercenaria		69.96-54.44%
Notonecta unifasciata	"axayacatl"	69.96-54.44%
Krizousacorixa azteca		69.94-54.44%
Krizousacorixa femorata		69.94-54.44%
Atizies taxcoensis	"jumiles de Taxco"[1]	70.30-51.25%
Corisella texcocana		71.52-58.25%
Corisella mercenaria		71.52-58.15%
Notonecta unifasciata	"ahuahutle"	71.52-58.15%
Krizousacorixa azteca		71.52-58.15%
Krizousacorixa femorata		71.52-58.15%
Homoptera (Treehoppers, Cicadas)		
Umbonia reclinata	Torito	32.73%
Hoplophorion monograma	periquito del aguacate	59.57-44.84%
Proarna sp.	chicharra[2]	72.02%

APPENDIX 2.–*Protein content of insects, expressed as a percentage of grams of protein per 100 grams of sample on a dry weight basis.* (continued)

Species (arranged in orders)	Common Name, Stage Consumed Notes	Percent Protein
Diptera (Flies)		
Ephydra (Hydropirus) hians	"gusano del agua", larvae	35.90%
Fam. Stratiomydae y syrphidae	"gusanos planos de maguey"	53.70%
Musca domestica	"gusano del queso," larvae	54.17%
Ephydra (Hydropirus) hians	"mosca del agua", adults	60.22%
Musca domestica	"gusano del queso", pupae	61.54%
Coleoptera (beetles)		
Olleus reinator	"ticoco"	20.91%
Aplagiognathus spinosus	"gusanos de elite podrido"	26.25%
Passalus af. punctiger	"bechano"	26.42%
Phyllophaga sp.	"gusano de la tierra"	29.68%
Sciphophorus acupunctatus	"picudo del maguey"	55.56%
Metamasius spinolae	"picudo del nopal"[2]	69.05%
Lepidoptera (butterflies and moths)		
Phassus sp.	"gusanillo"	34.34%
Xyleutes redtenbachi	"gusano rojo de maguey"	37.10-71.00%
Hylesia frigida	"mariposa del madroño"	41.93%
Heliothis zea	"gusano de maíz"[2]	41.98%
Synopsia mexicanaria	"pescaditos"	44.43%
Laniifera cyclades	"gusano del nopal"[2]	45.83%
Acalapha odorata	"Mariposa del muerto"	50.83%
Eucheria socialis	"gusano del madroño", larvae[2]	50.88%
Aegiale (acentrocneme) hesperiaris	"gusano blanco de maguey"[2]	51.00-30.28%
Arsenura armida	"gusano del jonote"	51.81%
Catasticta teutila	"gusano del muérdago"	66.58-59.78%
Eucheria socialis	"mariposa del madroño", pupae	71.60%

[1]Conconi, J. R. E. de and H. Bourges, 1977.

[2]Conconi, J. R. E. de and J. M. Pino M., 1979.

J. Ethnobiol. 4(1):73-92 May 1984

ALTERNATIVES TO TAXONOMIC HIERARCHY: THE SAHAPTIN CASE

EUGENE S. HUNN
Department of Anthropology
University of Washington
Seattle, Washington 98195

DAVID H. FRENCH
Department of Anthropology
Reed College
Portland, Oregon 97202

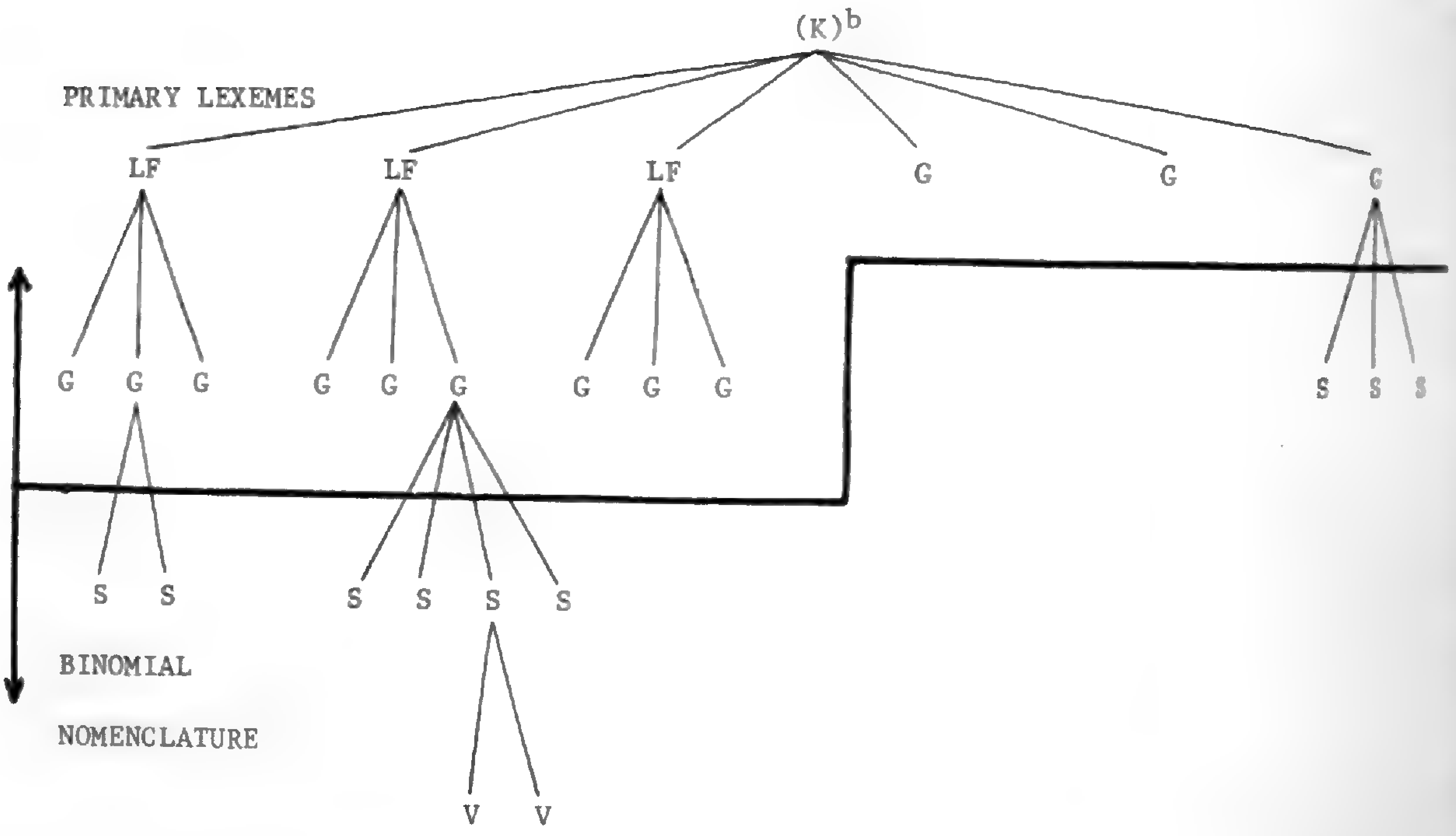
ABSTRACT.—The folk biological classification system of the Sahaptin-speaking Indians, a hunting-gathering people of the Columbia River Plain, is compared with other well documented systems. The Sahaptin system is notable for its lack of taxonomic hierarchy, especially in the rarity of binomial names. Such names imply taxonomic *subordination* of the binomially labeled taxon. Sahaptin speakers more frequently employ complex names which employ *coordination* of core and conceptually related peripheral taxa. An inventory of such names from one Sahaptin dialect group is analyzed. Explanations for the lack of hierarchy in Sahaptin folk biological classification and nomenclature are discussed. An evolutionary/functional explanation based on the relative sizes of the folk biological domains of hunter-gatherers versus subsistence agriculturalists is preferred.

INTRODUCTION

Studies of folk biological classification begin with the matching of names to corresponding segments of the biota. Since they do not end there, the next step is to seek to discover and analyze the organizing principles that structure these systems, which may then be compared cross-culturally.

Berlin's universal principles of folk biological classification and nomenclature (1973; Berlin, Breedlove, and Raven 1973), though based on limited comparative data, represent a pioneering effort at such cross-cultural analysis, and provide the framework for most subsequent studies of the structure of folk biological classification systems. His proposals have been supported (e.g., Brunel 1974; Hays 1974, 1983; Hunn 1975), extended (Brown 1977; Brown et al. 1976), criticized (e.g., Bulmer 1974; Hays 1983; Healey 1978-79; Hunn 1976, 1977; Randall 1976), and revised (Berlin 1976). This paper is intended as both critique and extension of Berlin's point of departure. We will argue that the taxonomic principle of inclusion by which taxa at one level or rank are subsumed by those of a higher level or rank—basic to Berlin's hierarchic scheme of folk biological classification, as it is to the Linnean—is but *one* way to organize a set of folk biological taxa. Furthermore, the associated binomial naming principle is one of several ways to indicate nomenclaturally structural relationships within folk biological classification systems (Fig. 1).

Our research with Sahaptin-speaking Indians of the Columbia Plateau region of the Pacific Northwest (Fig. 2) has shown Sahaptin to be an unusual case in comparison with folk biological classification systems previously described. Plant and animal classification by our Sahaptin-speaking consultants exhibits an extraordinary lack of hierarchic structure (French 1981). In fact, the system closely approximates the null point of taxonomic hierarchy, the single level system. Berlin has postulated that such a system should represent the initial stage in an evolutionary sequence of development of folk taxonomies (1972).



[a]LF = life forms, G = folk generics or basic level taxa, S = folk specifics, V = folk varietals, based on Berlin, Breedlove, and Raven (1973).

[b]The kingdom (K) rank is typically not named.

FIG. 1.—Idealized taxonomic structure indicating the relationship between taxonomic levels and ranks and showing the distribution of binomial nomenclature.[a]

Following Berlin's lead, Brown (1977, 1979) sought to demonstrate that named life form taxa, i.e., inclusive taxa at a level above that of the basic folk taxonomic level (the "folk generic" rank of Berlin), are added progressively to the folk biological inventories of the world's languages. Sahaptin is at an early stage of development, according to Brown's analysis, having a single botanical and a single zoological life form named, i.e., 'tree' and 'bird'. Of 217 cases sampled by Brown, only six are judged to have as few (5 cases) or fewer (one case) life forms (1977:324, 1979:796).

The minimal degree of hierarchic development in Sahaptin is even more apparent when Berlin's folk specific taxonomic level is considered. Berlin has compared a number of well documented folk botanical and zoological systems in terms of the percent of "folk generic" taxa subdivided by subordinate "folk specific" taxa, to which binomial names are characteristically applied (1976:389). These and an additional case are summarized in Table 1. There is a surprising degree of consistency to these statistics, with all except the Hanunóo falling in the range of 11% to 18% of basic level taxa being polytypic. Sahaptin stands in sharp contrast. The frequency of basic level polytypy for plant taxa is 1% (excluding recent coinages), with only two cases known, while that for animals is 2%, with four cases known.

It is misleading, however, to conclude that Sahaptin-speakers fail to perceive structure within their biological domains. Furthermore, they use nomenclatural means to indicate the structure they perceive, just as the use of binomial names may indicate relations of taxonomic hierarchy. We will describe two regular nomenclatural patterns employed in Sahaptin to indicate relationships among folk biological taxa. Both are more frequently employed than is binomial naming in Sahaptin folk biology. Both patterns reflect perceived resemblance or "kinship" among taxa. These relations *coordinate* taxa in direct contrast (cf. Lancy and Strathern 1981) rather than *subordinate* less inclusive taxa to those more inclusive.

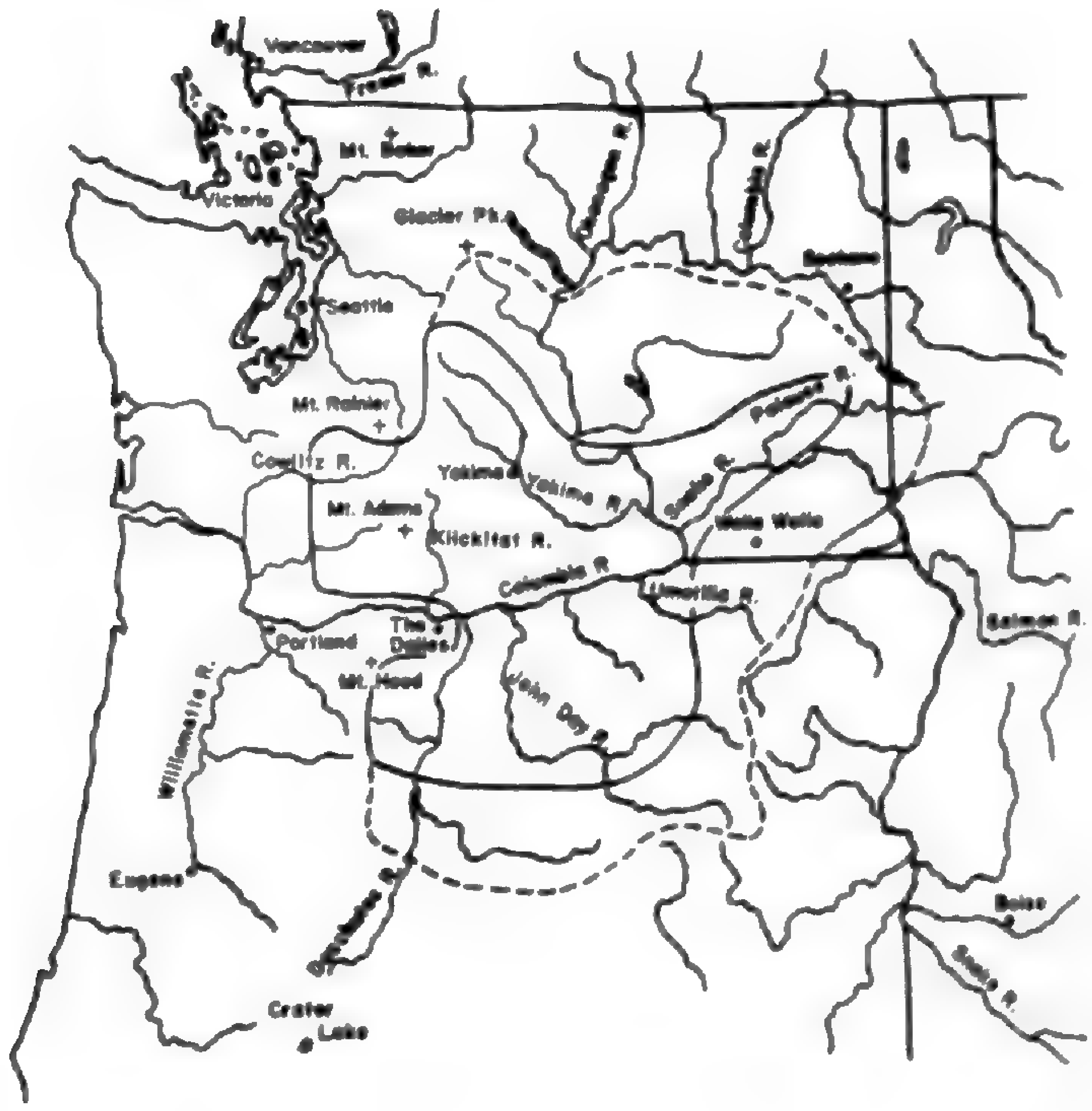


FIG. 2.–Map of the Pacific Northwest showing territory utilized by Sahaptin-speaking peoples. The central area indicates territory used primarily by Sahaptin-speaking peoples and under their control. The peripheral area indicates territory used annually by Sahaptin speaking peoples but in common with neighboring groups of other linguistic affiliations. Both areas are approximate. Reproduced from page 22 of Eugene S. Hunn, "Mobility as a Factor Limiting Resource Use in the Columbia Plateau of North America," pp. 17-43 in *Resource Managers: North American and Australian Hunter-Gatherers*. A.A.A.S. Symposium Volume 67, Westview Press, Boulder, Colorado.

Sahaptin speakers are much less likely to name a taxon by reference to its relationship to some other taxon—whatever the nature of that relationship—than speakers of other well known languages. The percentage of basic taxa named by reference to such relations in Sahaptin is substantially less than the percentage of binomially named taxa alone in comparable systems.

METHODS OF DATA COLLECTION AND ANALYSIS

In the Sahaptin case, we have consulted a variety of sources: 1) the naming responses of Sahaptin-speaking consultants to individual plants and animals examined *in*

TABLE 1.–*Degree of basic level polytypy in folk biological systems.*

System	Polytypy %	Number of Basic Level Taxa	Source
Sahaptin plants	1	213	Hunn 1980
Sahaptin animals	2	236	Hunn 1980
Chacan Quechua plants	11	n.a.	Brunel 1974
Ndumba plants	14	385	Hays 1974[a]
Ndumba animals	16	186	Hays 1983[a]
Tzeltal Mayan plants	16	471	Berlin, et al. 1974
Tzeltal Mayan animals	17	335	Hunn 1977
Aguaruna Jivaro plants	18	566	Berlin 1976
Hanunóo plants	36	n.a.	Conklin 1954

[a] These numbers represent the "shared" inventory, i.e., shared by nine of Hays' 10 informants. His totals are thus conservative compared with those reported by other researchers, who list a collective inventory.

situ or as pressed specimens, 2) discussions with consultants (conducted in English) of the characteristics of plants and animals (named in Sahaptin), and 3) comparable data reported by colleagues (K. French, V. Hymes, B. Rigsby, H. Schuster) and earlier ethnographers and linguists (M. Jacobs, E. Curtis, M. Pandosy, W. Everette). These data are of diverse quality. However, in the aggregate they represent several thousand instances of the naming of plant and animal taxa.

The key methodological issue is the operational definition of a *name*. In particular, names must be distinguished from more ephemeral constructions such as descriptive phrases, nonce forms, and idiosyncratic labels. Though a name may be constructed of two or more words, it is a single *lexeme* (Conklin 1962), that is, the referential meaning of the lexeme is not readily inferred from the referential meanings of its component morphemes or words. Thus, "silverfish" is not a silver fish and a "blackbird" is not just any bird which is black. For present purposes, a name must also reflect some degree of *consistency* of application across individuals and naming events. We have established the criterion for our data that to be considered a name a lexical expression must be employed consistently by at least two individuals on at least two independent occasions with the same referential meaning. This criterion is conservative in that it no doubt has led to the exclusion of some names from the corpus here considered. However, it provides a systematic means to exclude many (perhaps not all) nonce forms. This criterion is a necessary but not a sufficient condition for a lexical response to be considered a name. Expressions must also be considered appropriate responses to the query, "What is the name of X?" In Sahaptin this is ***tun i-wańik-ša.***"[2]

Sahaptin speakers are quite emphatic in denying the status of "name" ***(wańik-t)*** to responses considered to be transparently descriptive. It seems to us that this emic distinction is identical to or closely parallel to the linguists' distinction between noun lexemes and polylexemic expressions (Lyon 1977: Vol. 1, 18-25; Taylor 1982). We have also queried consultants about each named taxon concerning uses, distributional patterns, and morphological and behavioral features. When consultants are able to provide detailed ancillary information about a named organism, we feel justified in concluding that the name indeed refers to a distinct concept, a "semantically primitive" kind of living thing.

We are also concerned here with a particular class of names, that is, those which indicate syntactically a formal or structural relationship between the taxon named and some related folk biological taxon. Such *structure-defining names* necessarily will be morphologically compound and thus particularly difficult to distinguish from lexically compound expressions of parallel syntactic composition. English structure-defining names are typically (if not exclusively) of binomial form, as for example, "big-leaf maple" and "hammer-head shark." The binomial form of these names consistently indicates that the taxon so named is subordinate to the taxon named by the head constituent of the name. Such names must be carefully distinguished from descriptive phrases, such as "moss-draped maple" and "man-eating shark," and from metaphorical look alikes such as "poolshark," "poison oak," and "silverfish," already mentioned.

Parallel naming conventions have been described for a number of languages unrelated to English, and the binomial pattern may be universal (Berlin, Breedlove, and Raven 1973). The lexemic typology devised by Conklin (1962), since refined by Berlin (1973), recognizes the binomial name form as of privileged status, and the class inclusion relations indicated thereby have come to be seen as *the* fundamental structural principle of folk biological classification. The generality of binomial naming in folk biological nomenclatural systems, plus its incorporation as the basis of scientific biological nomenclature, has obscured the fact that this naming convention is just one of several naming patterns indicative of structural relations among taxa.

In Sahaptin there are *three* nomenclatural patterns commonly used to reflect *two* distinct types of formal relations among taxa. Binomial nomenclature used to indicate class inclusion is one of these. More frequently used in Sahaptin are two other naming patterns. These latter indicate relations of coordination—a relationship sometimes referred to metaphorically by Sahaptin consultants in terms of human social or kinship relations, as for example, dog, coyote, and wolf are said to be **náymu** 'relative/friend' of one another.

One of these coordinating naming patterns is superficially binomial, in that the name is formed of the modified name of a second taxon, which remains unaltered as the head constituent. The attributive constituent is the bound suffix-**wáakuł**, which may be glossed 'resembling' or, simple '-like'. For example, **c'iiławáakuł** is used to name Belding's ground squirrel *(Citellus beldingi)*, while **c'iiłá** *[c'ii* (onomatopoetic) + **-ła** (agentive)] names Townsend's and Washington ground squirrels *(C. townsendii, C. washingtoni).* Consultants who used this name (one each from the John Day and Umatilla dialects) distinguish Belding's on the basis of size, calls, and range. The suffix **-wáakuł** is also frequently employed to indicate similarity in a descriptive context, as when the color of a horse is described as **wiwnuwáakuł** 'huckleberry-like'.

The second Sahaptin syntactic convention used in coordinate naming is reduplication, often combined with sound symbolism. This is a highly productive syntactic feature of Sahaptin (Jacobs 1931:135-140; Rigsby n.d.) indicating variously diminution, distributive plurality, and—as here—the status of "younger sibling," i.e., the resemblence of a conceptually peripheral taxon to the more central or salient prototype. For example, **k'usík'usi** 'dog' is derived by this process from **k'úsi** 'horse'. This naming process is not restricted to recently introduced species such as the horse; it is also used, for example, in naming a species of *Vaccinium* that is a traditionally favored food item, **wiwlúwiwlu** 'grouseberry' *('Vaccinium scoparium* Leiberg)[3], derived from **wíwnu** 'black mountain huckleberry' *(V. membranaceum* Dougl. ex Hook.), the archetypical fruit for Sahaptin speakers.

Such relations of coordination of similar plants and animals may be *described* in English (or in other languages including Tzeltal), but such descriptive expressions as "dog-like" in English or *"kol pahaluk sok šuš"* 'almost the same as wasp' in Tzeltal are never used as names. The status of the parallel Sahaptin forms as true names is suggested by the fact that the nonce form ***wiwluwiwluwáakuł*** has been recorded (in response to an ambiguous *Vaccinium* specimen), as has the binomial ***tanán sit'x̣ʷswáakuł***, literally, 'Indian corn', from ***tanán*** 'Indian', plus *sít'x̣ʷs* '*Brodiaea hyacinthina* (Lindl.) Baker', plus ***-wáakuł*** '-like'.

A DISCUSSION OF THE SAHAPTIN CASES

Binomial Names.—The Sahaptin use of binomial nomenclature is sporadic, at best, and at times appears to be actively avoided. One simple case of binomial nomenclature involves the recognition of two species of raspberry:

(1) ***šáx̣at*** →
- ***čmúk šáx̣at***, lit. 'black raspberry'
- ***luc'á šáx̣at***, lit. 'red raspberry'

Since the red raspberry *(Rubus idaeus* L.) is rare in the Sahaptin range, the unmodified generic term ***šáx̣at*** is normally used to label the common blackcap raspberry *R. leucodermis* Dougl.) (cf. Curtis 1911:175).

The naming and classification of willows *(Salix* spp.) in Sahaptin is complex. The general term is ***ttáx̣š (táx̣š*** in NW dialects). However, the large, erect peachleaf willow *(S. amygdaloides* Anderss.) is singled out as ***habáw***. It is unique among the willows in its straight, nearly branchless bole (Peattie 1950:346-347), and thus is favored for long-house framing. The categories ***habáw*** and ***ttáx̣š*** are seen as closely related but distinct taxa. Other native willows (e.g., *Salix exigua* Nutt. ssp. *exigua* var. *exigua, S. rigida* Muhl. var. *mackenzieana* (Hook.) Cronq., *S. scouleriana* Barratt, *S. lasiandra* Benth. var. *caudata* (Nutt.) Sudw.) as well as the introduced willows *(S. alba* L. var. *vitellina* (L.) Stokes, *S. babylonica* L.) are ***ttáx̣š***. This term may be modified, though without great consistency, as ***puˀúx̣puˀux̣ ttáx̣š*** 'gray willow', often used to refer to the shrubby, gray-leaved coyote willow *(S. exigua),* and ***pt'x̣anupamá ttáx̣š*** 'mountain-forest willow' for Scouler willow *(S. scouleriana),* the typical large willow of the montane zone. Other willows are "just" ***ttáx̣š*** 'willow', which creates a "residual category" (Hunn 1977:57-58), labeled [R] in the diagram below.

(2) ***habáw*** 'peachleaf willow'

ttáx̣š →
- [R] ***ttáx̣š*** 'residual willow.
- ***puˀúx̣puˀux̣ ttáx̣š*** 'coyote willow'
- ***pt'x̣anupamá ttáx̣š*** 'Scouler willow'

Chokecherry *(Prunus virginiana* L. var. *demissa* (Nutt.) Torr.) provides an interesting comparison. Chokecherries are an important traditional food. The cherries vary in color from red to black, but discontinuously so that three color types are readily recognized. Modern-day Sahaptins are aware of this variation but refused to apply binomials to label the variants, even when prodded to do so. Several consultants rejected ****čmúk tmíš***, literally 'black chokecherry' and ****luc'á tmíš*** 'red chokecherry', while accepting the parallel raspberry names. They asserted that this variation among chokecherries is of no significance.

The four acceptable examples of binomial naming applied to animals are neither very widely nor very consistently used. Two informants distinguished the rare snowy owl *(Nyctea scandiaca)* as ***qúyx̣ miimánu***, literally, 'white large owl'. Unmodified ***miimánu*** calls to mind as prototype the great horned owl *(Bubo virginianus)*, the most common and the most powerful owl in the region. This is attested by consultants' descriptions of ***miimánu*** vocalizations, appearance, and habits. The term ***miimánu*** is now also extended to other medium to large owls, such as the barn owl *(Tyto alba)* and short-eared owl *(Asio flammeus)*, when examples of these species are presented for naming. This may indicate that contemporary speakers have never learned the "proper" names for these owls. Although this naming pattern might suggest that the snowy owl is considered a *kind of* great horned owl, such is not the case. The snowy owl is seen as a related, but coordinate form, on the same taxonomic level as ***miimánu***. The situation might be interpreted taxonomically if we were to posit two polysemous senses of ***miimánu*** (cf. Berlin 1976:391-392), as follows:

(1) ***miimánu***$_2$ 'large owl' → ***miimánu***$_1$ 'great horned owl'
→ ***qúyx̣ miimánu*** 'snowy owl'

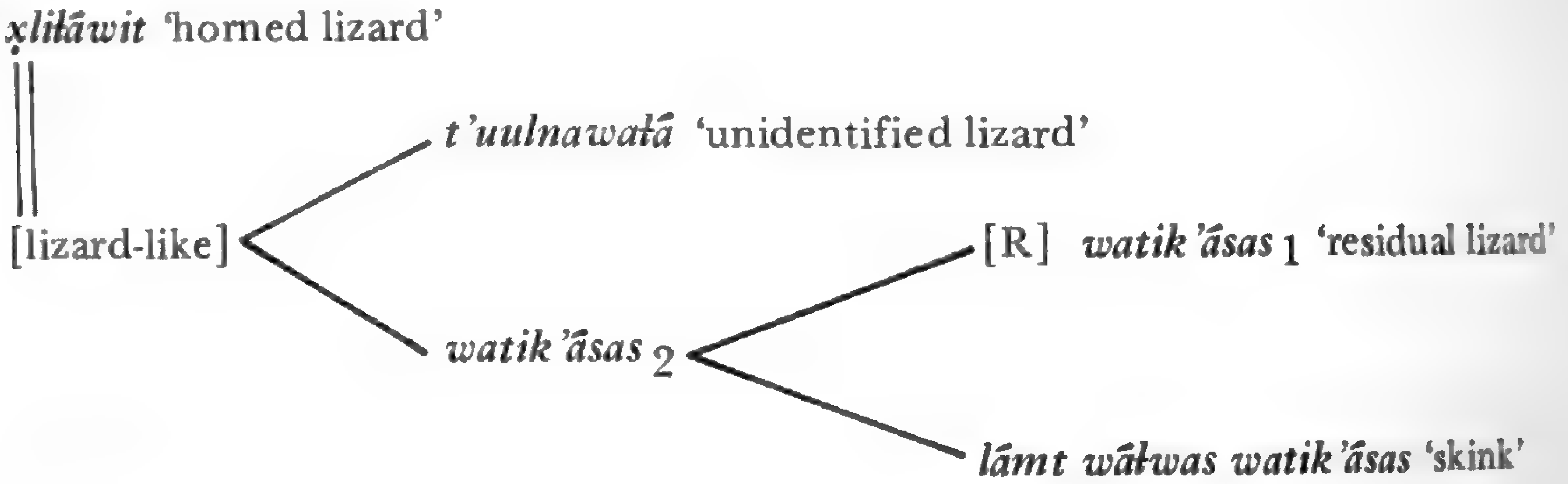
However, this interpretation is hypothetical, Snowy Owl illustrations were never identified as unmodified ***miimánu*** (and their rarity prevented evaluation of naming responses in more realistic settings), and in the single myth recorded in which Snowy Owl is a character the binomial expression was used exclusively. Thus it is not possible to determine if ***qúyx̣ miimánu*** is more like the English "pack rat" (a kind of rat) than "musk rat" (which is not a kind of rat).

Several consultants distinguish black-tailed jackrabbits *(Lepus californicus)* from their white-tailed cousins *(L. townsendii)*.

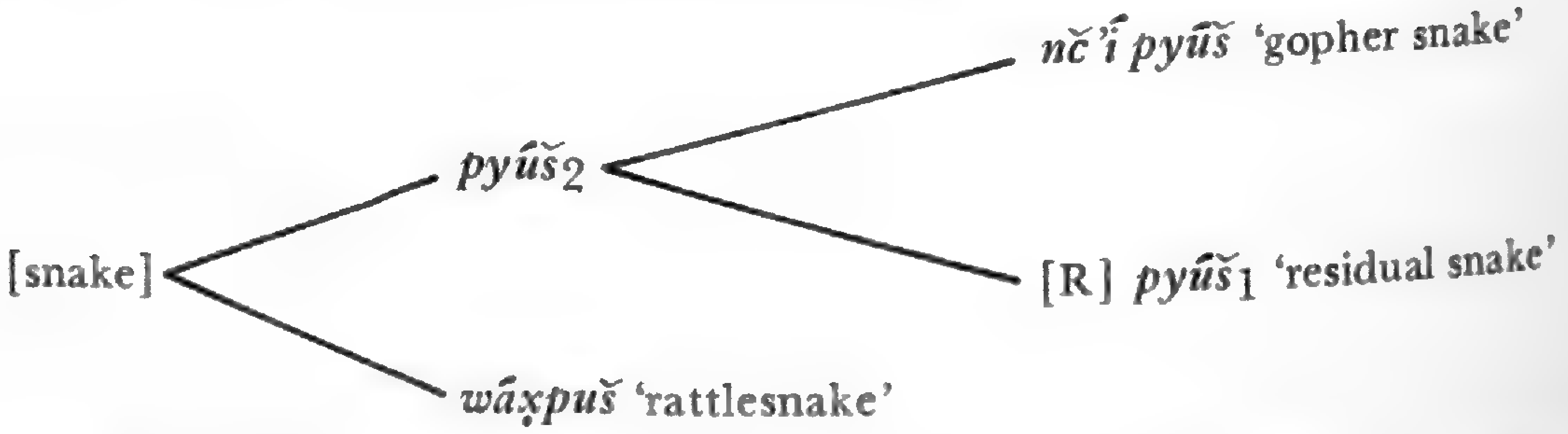
(2) ***wilalík*** → ***pláš (=qúyx̣) wáɬwas (=twiní) wilalík***[4], literally 'white-tailed jackrabbit'
→ ***čmúk wáɬwas wilalík***, literally 'black-tailed jackrabbit'

State of Washington consultants are quick to note that the black-tailed species is a modern-day intruder, having expanded its range north of the Columbia River in the past 60 years. In Oregon, where both species are longtime residents, Sahaptin speakers "mark" the less common white-tailed jackrabbit as ***qúyx̣ twiní wilalík*** in contrast to the black-tailed jackrabbit, known simply as ***wilalík***.

Typical lizards are called ***watik'ásas***, a name which applies with equal force and without modification to fence lizards (two species of *Sceloporus*), and the side-blotched lizard *(Uta stansburiana)* [and possibly alligator lizards (two species of *Gerrhonotus*)]. The western skink *(Eumeces skiltonianus)* was singled out as ***lámt wáɬwas watik'ásas***, literally, 'blue-tailed lizard', by two consultants from contrasting dialect groups. The skink's tail is used as a good luck charm in gambling. Two lizards are not included in ***watik'ásas***, but are contrasting basic level taxa: ***x̣liɬáwit***, literally 'of root diggers', is the shorthorned lizard *(Phrynosoma douglassi)*, and ***t'uulnawaɬá***, literally 'jumper', is of uncertain identity.[5] Both are morpohologically divergent species. Though ***t'uulnawaɬá*** is clearly thought of as a lizard-like creature, the horned lizard (n.b., "horned toad" in colloquial English) is not. The horned lizard is in addition considered to be an "Indian doctor" worthy of special respect and protection.

(3)


Typical snakes are called ***pyûš***, with the abundant garter snakes (three species of *Thamnophis)* considered unexceptional examples. This name also may be applied unmodified to the racer *(Coluber constrictor)* and the gopher snake *(Pituophis melanoleucus),* two other common species. However, the gopher snake was named ***nč'î pyûš***, literally, 'big snake', by at least three consultants of as many dialects. Others apply a contrasting basic level term, ***ppâw***, to this species (Johnson-O'Malley 1977), perhaps reflecting a more differentiated nomenclature before Euro-American settlement. Individual consultants have on occasion used additional binomials to distinguish garter snakes and racers, but such usages failed to meet our nomenclatural standard for consistency of application. The western rattlesnake *(Crotalus viridus)*–like the horned lizard, an "Indian doctor"–is not considered to be a kind of ***pyûš***, though its name, ***wâxpuš***, clearly suggests an etymological link with ***pyûš*** now obscure to native speakers. Thus 'snake', as we understand it, remains a covert category in Sahaptin.

(4)


All four cases of binomial nomenclature among animals involve a minimal development of the specific contrast set. In three cases a binomial name is applied to one exceptional "species" within a folk "genus"–or possibly to a coordinate form in the case of the snowy owl–while the other member(s) of the genus is (are) not distinguished by a parallel binomial. Thus it would be necessary to postulate an unmarked polysemous type-specific category in three of four cases in order to preserve the hierarchic form of the taxonomic model.

Expressions of Binomial Form which are not Valid Specific Names.–Binomial names in which the head component of the name refers to a taxon superordinate to the basic level were not treated above (very few cases are known for Sahaptin). This accords with Berlin's distinction (1973:217) between "primary" names such as "mockingbird," which contrast with such names as "robin" (*not* "robinbird"), and "secondary" names, the true binomials, such as "bald eagle," which contrasts with "golden eagle," a name with parallel structure. One example of a "binomial name" at the basic level in Sahaptin is the form ***tkʷnat nûsux̣*** 'Chinook salmon', more usually and simply rendered ***tkʷînat*** (for *Oncorhynchus tschawytscha).* The taxon ***nusûx̣*** 'anadromous salmonid' includes up to seven basic level categories (Hunn 1979), but spontaneous binomial combinations have been recorded only for ***tkʷínat***, the prototype of ***núsux̣***.

(1) ***núsux̣*** 'salmon/steekhead'
- ***tkʷínat (núsux̣)*** 'Chinook salmon, typical'
- ***tkʷiláttkʷilat*** 'jack Chinook salmon'
- ***sínux̣*** 'silver salmon'
- ***kálux̣*** 'blueback salmon'
- ***mit'úla***$_1$ 'dog salmon'
- ***šušáynš*** 'steelhead'

The category ***núsux̣*** may be considered a small "life form" (as there is no general term for 'fish' in Sahaptin) or a named intermediate level taxon (see Berlin, Breedlove, and Raven 1973), as it includes several basic level taxa. A similar situation holds among names for coniferous trees, at least as Sahaptin is spoken today. Spruce trees *(Picea engelmannii* Parry ex Engelm.) may be called ***qutqút patátwi*** 'prickly fir'. However, ***patátwi*** also includes a number of trees known by primary names, e.g., ***waqutqút*** 'hemlock', ***táp'aš*** 'Ponderosa pine', and ***naníkaaš*** 'white-bark pine'. The occasional use of a primary name for spruce, ***mic'ípaas***, literally, 'itchy tree/shrub', suggests that the binomial term is a recent replacement for the "true name" now forgotten.

(2) ***patátwi***$_2$ 'coniferous tree'
- ***patátwi***$_1$ 'balsam firs, especially the subalpine fir, extended to the Douglas fir'
- ***pápš*** 'Douglas fir, or large fir in general'[6]
- ***qutqút patátwi/mic'ípaas*** 'spruce'
- ***waqutqút*** 'hemlock'
- ***kimíla*** 'larch'
- ***wawanínš*** 'yew'
- ***táp'aš*** 'Ponderosa pine, sometimes extended to pines in general'
- ***kalámkalam*** 'lodgepole pine'
- ***naníkaaš*** 'white-bark pine'

More than 20 varieties of ***k'úsi*** 'horse' are recognized nomenclaturally by contemporary consultants (a more exact count is not possible due to the productivity of binomial labeling used to describe horses). These varieties are labled as in the following examples: ***máamin*** 'appaloosa', ***kawxkáwx*** 'palomino', ***luč'á*** 'bay' (from ***luč'á*** 'red'), and ***wiwnuwáakuł*** 'huckleberry roan' (literally 'huckleberry-like'). It is acceptable to say ***máamin k'úsi*** 'appaloosa horse', but such a binomial variant is rarely noted in normal naming contexts or in conversation, even when the modifier is a widely used adjective such as ***čmúk*** 'black', which thus may also mean 'black horse', according to context. In a few instances there is a further subdivision of specific horse names into varieties which may be named binomially, as for example, ***čmúk šiwíwšiwiw*** 'black roan'. Sahaptin horse classification illustrates an unusual elaboration of Sahaptin nomenclature that is a consequence of a recently introduced biological phenomenon, a domesticated, and thus extremely variable organism. We have thus excluded horse varietal terms from present consideration. The very large number of recognized horse varieties is also anomalous with respect to the expected distribution of polytypy (Geoghegan 1976), a pattern consistent with the recent incorporation of the horse in Sahaptin culture.

We have also excluded cases in which a heterogeneous basic level taxon is frequently but idiosyncratically or inconsistently further specified binomially. Examples include ***łšáy*** 'worm/caterpillar/maggot' and ***kliwisá*** 'ant'. Variation within these broad categories may be noted by reference to color, behavior, habitat, or host organism, but the forms seem clearly to be on-the-spot inventions to entertain the ethnographer. Finally, we have excluded cases involving recently introduced species. The binomial expression ***tanán*** X, literally 'Indian X', is used by a few consultants to distinguish native forms from related introduced forms. For example, one consultant contrasted ***tanán šáak*** 'Indian onion', the wild species of *Allium*, with ***šáak*** proper, which this consultant restricted to garden onions. Another individual referred to an ear of varicolored "Indian corn" as ***tanán sit'x̣ʷswáakuł***, literally 'Indian corn'. These usages, besides being recent, are idiosyncratic and sporadic.

The Suffix ***-wáakuł*** *'-like'*.–This naming convention is much more frequently used in botanical names than in the zoological. Our single animal case is the ground squirrel example cited above.

(1) ***c'iiłá*** 'Townsend's/Washington ground squirrel'

└──────── ***c'iiławáakuł*** 'Belding's ground squirrel'

Plant examples are as follows:

(2) ***anipáš*** '*Claytonia lanceolata* Pursh'

└──────── ***anipašwáakuł*** '*Montia sibirica* (L.) Howell

The first named is an "Indian potato"; the second is a striking look-alike and close relative, lacking underground tubers. In fact, the presence of a tuberous root is a trait used by certain botanists to distinguish *Claytonia* from *Montia*. This use of ***anipašwáakuł*** was recorded by Gunther during a 1935 ethnobotanical survey in western Washington (1973:29) and is current on the Warm Springs Reservation in eastern Oregon.

(3) ***č'íši*** '*Purshia tridentata* (Pursh) DC.'

└──────── ***č'išiwáakuł*** '*Cercocarpus ledifolius* Nutt.'

Purshia and *Cercocarpus* are large shrubs or small trees of the rose family (Rosaceae). *Purshia* is widespread, while *Cercocarpus* is found only on the southeastern fringe of the Sahaptin range.

(4) ***nánk*** '*Thuja plicata* Donn.'

└──────── ***nankwáakuł*** '*Calocedrus decurrens* (Torr.) Florin.'

This Warm Springs case is precisely parallel to the preceding but involves two large tree species of the cypress family (Cupressaceae); *Thuja* is common and widely used, while *Calocedrus* is known only from the southwestern corner of the Sahaptin range.

(5) **sáx̣i** '*Philadelphus lewisii* Pursh'

└── **sax̣iwáakuł** '*Symphoricarpos albus* (L.) Blake'

Here two shrubs, though not closely related, share the characteristic of opposite leaves. Both are common, widespread, and useful; *Philadelphus*, in the rose family, as a durable wood and source of soap; *Symphoricarpos*, in the honeysuckle family (Caprifoliaceae), as a medicine. The "junior status" of *Symphoricarpos* may be because of its shorter stature and smaller leaves and flowers.

(6) **suspấn** '*Fragaria* spp.'

└── **suspanwáakuł** '*Geum triflorum* Pursh'

Here the strawberry *(Fragaria)* is compared to another herbaceous species of the same family (Rosaceae). The strawberry is a favorite though incidentally important food; *Geum triflorum* is used medicinally.

(7) **tawšá** '*Artemisia tridentata* Nutt.', 'big sagebrush' in part,

└── **tawšawáakuł** '"*A. vaseyana*," a montane ecotype of *A. tridentata*, and *A. arbuscula* Nutt.'

Tawšá is abundant at lower elevations, occasionally attaining the stature of a small tree. It has incidental technological applications and is a medicine. *Tawšawáakuł* is a form dwarfed by high elevation *("A. vaseyana")* or impoverished soils *(A. arbuscula)*.

(8) **tmíš** '*Prunus virginiana* L.'

└── **tmišwáakuł** '*P. emarginata* (Dougl.) Walp. and domestic *P. cerasus* L., etc.'

The conceptual priority of the chokecherry *(P. virginiana)* presumably is because of its value as a highly regarded food. Bitter cherry *(P. emarginata)* is not eaten here but has technological and medicine value. The inclusion of the domestic cherries *(P. cerasus*, etc.) gives the derived category a residual quality, that is, we might gloss **tmišwáakuł** as 'any cherry but the chokecherry'.

(9) **wák'amu** '*Camassia quamash* (Pursh) Greene'

└── **wak'amuwáakuł** '*Iris missouriensis* Nutt'[7]

Camas *(Camassia)*, in the Liliaceae, is a staple root food while the iris, Iridaceae, is not used. Both are showy monocots with grass-like leaves.

The terms for corn and tomatoes provide two additional examples of the use of plant names modified in this way. Both are introduced domesticates, though corn may have been known to Sahaptins before Euro-American contact. Corn is almost universally known as **sit'x̣ʷswáakuł**; its namesake **sit'x̣ʷs** is *Brodiaea hyacinthina* (Lindl.) Baker in the lily family, valued for its edible corms. The resemblance perceived, however, is not between corn and the lily *as plants*, but in the form of the edible portions of each, the kernel of corn fancied to resemble the corm of the *Brodiaea*. Our second example is precisely comparable. The introduced tomato is often called ***šč'apawáakuł*** 'rosehip-like', and indeed a tomato's fruit bears a substantial superficial resemblance to the fruit (hip) of the native roses. These two cases are intermediate between the instances described above in which two taxa are closely related conceptually on the basis of overall morphological resemblance, and instances in which the perceived resemblance is based on some single characteristic shared by the "prototype" and the form compared to it, as when a "huckleberry roan" is called ***wiwnuwáakuł*** 'huckleberry-like' based on shared color.

Reduplication.—This naming pattern is less frequent than the preceding, but it is used in the same way to link a simply named prototype to a derivatively named form (or forms) perceived to be closely related. It usually carries the additional implication of relatively smaller size. Botanical examples include the huckleberry case already cited:

(1) ***wíwnu*** '*Vaccinium membranaceum* Dougl. ex Hook'
└── ***wiwlúwiwlu*** '*V. scoparium* Leiberg'

The prototype in this case is a highly valued staple food; *V. scoparium* is also eaten, but more as an incidental treat. Both the shrub and fruit of *V. scoparium* are dwarfed. In some Sahaptin dialects taller native onions are called ***šáak***, while low-growing species are ***saaksáak***:

(2) ***šáak*** 'taller wild onions'
└── ***saaksáak*** 'low-growing wild onions'

A similar (or identical?) contrast is handled differently in other dialects, in which the taller onions of wet meadows are called ***qʷláwi*** and the low-growing rock onions are ***sámamwi***.

Zoological examples include the following:

(3) ***tkʷínat*** 'typical *Oncorhynchus tschawytschwa*'
└── ***tkʷiláttkʷilat*** '"jack" *Oncorhynchus tschawytscha*'

The "jack" of the Chinook salmon is a form of that species that returns to spawn a year earlier than is typical. They are identifiable by their smaller size. The "jack" is not considered a kind of ***tkʷínat***, but a "species" of salmon in its own right. The next two cases are close parallels.

(4) ***apín*** 'head louse'
└── ***apílapił*** 'small swarming invertebrates'

Examples of the latter include aphids and the larvae of mosquitoes.

(5) ***ístx̣ní*** 'horse fly, typically, extended to include other large biting flies'
└── ***istx̣líistx̣li*** 'gnats'

Our final example is the intriguing case of the horse and dog. Contemporary Sahaptin speakers, as well as those who served as Pandosy's informants (1862), call the dog ***k'usí-k'ûsi***, literally 'little horse'. However, the horse is the more recent introduction (Haines 1938). Dogs are known from the Pacific Northwest archaeologically since 10,400 BP (Lawrence 1968), and thus must have been the original referent of ***k'ûsi***. Horses were likened to dogs presumably because of the role they came to play in human social economy as highly useful and esteemed (but inedible) pets. The horse's large size and rapid incorporation as an essential mode of transport and currency of social exchange apparently produced the semantic shift now evident:

(6) ***k'ûsi*** 'horse'
  └──── ***k'usikûsi*** 'dog'

A similar process occurred in Tzeltal with deer and sheep and peccaries and pigs (Berlin 1972:82-83).

We have not counted here cases of reduplication used to name early growth stages of a plant or animal, such as ***aluqâtaluqat*** 'recently emerged frog/toad', from ***aluqât*** 'adult frog', and ***tap'âytap'ay*** 'Ponderosa pine seedling', from ***tâp'aš*** 'Ponderosa pine'. We have not counted ***lalíklalik*** 'columbine' (*Aquilegia formosa* Fisch.), derived from ***naník*** 'seed of white-bark pine', as the resemblance is drawn between the seeds of the respective plants only, a naming pattern like that of corn and tomato.

Implicit Recognition of Prototype/Satellite Structural Relations.—The coordinate relationship between a prototypical category and one or more satellite taxa—explicitly recognized in the above examples by reduplication or the suffix ***-wâakuɫ*** '-like'—is frequently implicit in Sahaptin. Such implicit relationships are manifested by consultants' statements that taxon *X* is similar or related to taxon *Y* or by patterns of identification errors (Hays 1976). In each of the following cases a heterogeneous basic level taxon has a closely associated satellite taxon which—if not named in its own right—would be subsumed by the heterogeneous category as within the "sphere of influence" of the prototype (cf. Bright and Bright 1965).

(1) ***x̣âtx̣at*** 'duck in general with the mallard prototypical', except for,
  └──── ***tâštaš*** 'common merganser'

(2) ***pyûš*** 'snake in general with variable focus', except for,
  └──── ***wâx̣puš*** 'rattlesnake'

(3) ***watik'âsas*** 'lizard in general with *Sceloporus/Uta* apparently protypical', except for,
  └──── ***t'uulnawalâ*** 'unidentified lizard'[5]

(4) ***kliwisâ*** 'ant in general with *Formica* spp. prototypical', except for,
  └──── ***tâmšuy*** 'a species of small, non-biting, black ant'

(5) ***wix̣alx̣alí*** 'spider in general with no apparent prototype', except for,
  ├──── ***tíšpun*** 'black widow spider', and
  └──── ***kâatlam wux̣â*** 'harvestman', literally 'long-leg'

(6) ***ttáx̣š*** 'willow in general with no apparent prototype', except for,

└──→ ***babáw*** 'peachleaf willow'

The rattlesnake and black widow spider are significant dangers; the peachleaf willow, due to its atypical growth form, is of special utility; while the common merganser warned Columbia River villagers of the approach of Paiute Indian raiders. In these cases the special utility of the satellite taxon seems of paramount significance in motivating its special recognition. Morphological singularity seems the dominant factor in the cases of ***t'uulnawałá*** and the harvestman. Why ***támšuy*** is deemed worthy of special attention remains a mystery.

DISCUSSION

We have examined 21 legitimate cases (and a number of marginal ones) in which pairs of taxa conceived to be related are linked nomenclaturally. In all cases the pattern is similar: the prototypical taxon provides the nomenclatural base for naming the peripheral relative. This pattern is obvious in the cases of reduplication (N=6) and in the use of the suffix ***-wáakuł*** '-like' (N=9). It is somewhat less clear in the binomally labeled cases (N=6). However, at least in the case of the snowy owl the binomial ***qúyx̣ mɨimánu*** carries no implication of taxonomic subordination to the unmarked prototype, ***mɨimánu*** 'great horned owl'. Thus at least 16 of 21 (76%) of these cases of indirect naming involve conceptual *coordination* between basic level taxa, one focal, the other peripheral, rather than hierarchic *subordination* between taxa at higher and lower levels or ranks of a taxonomy.

Sahaptin also contrasts with other cases cited in the literature in terms of the extent to which indirect naming of any sort is used. The percentage of taxa named by reference to other taxa, either by reference to a superordinate taxon or a coordinate, prototypical taxon, is 5%, compared to ca. 35% *binomially* named taxa in Tzeltal (Berlin, Breedlove, and Raven 1974:37; Hunn 1977:79). Thus, not only do Sahaptin speakers avoid subordinating one taxon to another nomenclaturally, but they also are less given to naming one taxon in terms of another. A related observation is that Sahaptin consultants are skeptical of "names" which are transparently descriptive of either form or function. For example, thistles (*Cirsium* spp.) are always referred to as ***qutqút***, literally 'thorny'. In the same breath, consultants aver that ***qutqút*** is not the plant's "real name." No consultant has been able to recall what the "real name" is, but all agree it is not ***qutqút*** and that a "real name" does in fact exist. Consultants react similarly to the label ***tutanikpamá***, literally 'for the hair', applied to a variety of plants used "medicinally" to make their hair grow long or to prevent graying. By contrast, Tzeltal speakers freely accept names of the form '*X*-medicine'. This Sahaptin naming style may reflect a belief in the essential power of names. Naming ceremonies and the inheritance of ancestral names is a focal point of Sahaptin ritual observance even today. However, it is not clear that Sahaptin speakers differ in their regard for the sacred power of names from speakers of languages which use indirect naming more freely. Such a connection should be investigated.

The Sahaptin nomenclatural pattern we have described may be interpreted in several ways. These interpretations might be of three types, the pattern being: (1) illusory, (2) stylistic, or (3) evolutionary. Those who argue for the pattern as illusion might assert that the Sahaptin data are the result of a degenerative process due to acculturation. Perhaps the pre-contact Sahaptin system more closely resembled the Tzeltal, Ndumba, Aguaruna, or Hanunóo systems in reliance on binomial naming. The restricted Sahaptin ethnobiological inventory, i.e., 450 Sahaptin basic level taxa versus 571 in Ndumba, 813 in Tzeltal, 1000+ in Aguaruna, and 1000+ in Hanunóo, might suggest that the presently accessible inventory is significantly less than it once was. If acculturative losses disproportionately affect productive lexemes, we should expect acculturated systems to exhibit a smaller percentage of binomial names than fully viable systems.

We do not believe acculturative loss explains the Sahaptin data. First, though it is likely the pre-contact system was larger, it is doubtful that it was ever as large as the comparison systems for the basic reason that the ecosystems familiar to the Sahaptin people are less rich in species than those of the Tzeltal, Ndumba, Aguaruna, or Hanunóo, all in humid, tropical environments. Furthermore, there is continued nomenclatural recognition of some very similar and closely related species, as those of the genus *Lomatium* (Hunn and French 1981). Although one might expect binomials to be applied to such cases, they are not. We call attention also to the fact that in many languages binomials are most frequently employed in naming species of high cultural salience (Berlin, Breedlove, and Raven 1973:216). Such names are likely to be disproportionately persistent under acculturation. Finally, we note that in several instances binomials and other productive lexemes have recently replaced unanalyzable linguistic expressions in Sahaptin nomenclature as in the examples cited of ***qutqût patâtwi*** 'spruce' and *nč'î pyûš* 'gopher snake'. Thus indirect naming may be more frequent in contemporary Sahaptin than it was pre-contact.

It may be argued that patterns of naming simply reflect styles peculiar to the "genius" of one language or another. We may appreciate such variation as illustrating the rich diversity of human cultures, but draw no more general conclusions. For example, French (1960) has documented dramatic differences in naming responses between samples of native speakers of Sahaptin, Upper Chinookan, and English to standardized collections of plants. Sahaptin speakers much more frequently labeled unfamiliar plants with nonce forms indicating perceived relationship or similarity, i.e., of the form ***X-wáakuɬ*** 'like-*X*', while Upper Chinookan speakers simply said, "I don't know."[8] English speakers were particularly inclined to invent names or to subsume unfamiliar plants within known categories. However, if the predilection for the use of binomial names were purely stylistic, Berlin's universals could not be relied upon (1973). The consistency with which binomials are applied for example in Tzeltal, Ndumba, Aguaruna, and Hanunóo, is strong contrary evidence. It is also noteworthy that published exerpts from languages such as Eskimo (Irving 1953), Groote Eylandt (Waddy 1982), Agta (Headland 1983), and Khoisan (Lee 1979:464-478) suggest that these languages might closely resemble Sahaptin in their disuse of binomials. It is at least suggestive that the former set of languages are of subsistence farmers, the latter of hunter-gatherers. This brings us to our third alternative type of explanation.

Evolutionary explanations of this nomenclatural pattern may be of three basic types, reflecting the evolution of: (1) intellectual capacities, (2) social organization, or (3) ecological and economic systems. There are respectable proponents of each of these evolutionary perspectives. For example, Berlin (1972) argues that folk biological classification systems evolve in two steps; the initial step is one of "horizontal" expansion of the set of basic folk taxa by an analogical process of "concrete transposition." What we have labeled *coordination* here is an example. The subsequent evolutionary step—which complements but does not supplant the first—is one of "vertical" expansion from the basic folk taxa by means of generalization to produce named life-forms and, ultimately, the unique beginner, and of differentiation, to produce folk specific and varietal taxa. Binomial names are indicative of this latter process. From this perspective *subordination* is a superior mode of classification, being more "abstract" than coordination. We believe this assessment has no basis in fact, but rather represents the bias of speakers of a language, English, that has enshrined binomial nomenclature as the scientific ideal. To recognize that *X* is like *Y* requires abstraction fully as much as to recognize that *X* is a kind of *Y*.

Durkheim and Mauss argued in *Primitive Classification* (1963) that the conceptual recognition of hierarchy, as in a taxonomy, is a byproduct of the experience of social hierarchy. Thus one might argue that Sahaptin folk classification lacks hierarchical development comparable to that of the Tzeltal because the pre-contact Sahaptin speakers were egalitarian hunter-gatherers within an acephalous polity, while the Tzeltal Mayans had long known the reality of state and nation. This hypothesis is tempting in that Sahaptin social relations stress coordination and do not emphasize subordination. Though chiefs (***miyâwax̣***) were recognized, their power was limited. Much more salient were bilateral kin ties and dyadic trading partnerships between 'friends' (cf. Marshall 1977). There is a curious parallel between the Sahaptin stress on individual autonomy and their stress on the essential uniqueness of plant and animal names. However, it is patently false that Hanunóo—which surpasses Tzeltal in degree of taxonomic hierarchy in the folk biological domains as far as Tzeltal surpasses Sahaptin—have experienced extremes of social hierarchy. Furthermore, the Wasco/Wishram place considerably greater stress on social hierarchy than do their Columbia River Sahaptin neighbors, yet share their aversion to hierarchy in their folk biological classifications. It seems the apparent correlation of taxonomic hierarchy with social hierarchy may be an epiphenomenon of the underlying subsistence systems. This brings us to a consideration of the third evolutionary perspective, the ecological.

The pattern we have observed here suggests that folk biological classification systems have evolved from a single-tiered system of coordinate taxa among hunter-gatherers to a multi-tiered system (a taxonomic hierarchy proper) exhibiting a high incidence of basic level polytypy (Geoghegan 1976) among subsistence agriculturalists. A further stage of development (or of devolution, if you will) has been suggested (Dougherty 1978, Brown 1979) to account for the progressive increase in the number of highly inclusive morphologically based life-form categories and parallel reduction in numbers of basic level taxa. The initial phase of this evolutionary pattern might be explained by reference to the process of domestication. Diverse cultivars might reasonably have been the initial recipients of binomial names. They are very commonly applied in such instances. However, many wild plants and animals are also so named. Therefore, we must assume a process of generalization whereby binomial naming was extended to wild relatives of cultivated plants and animals, then used to label any closely similar set of plants or animals, domesticated or wild. The fact that the degree of polytypy among Tzeltal zoological terms is virtually identical to that of Tzeltal botanical terms—despite the far greater role of domesticated plants than of animals in Mayan subsistence—indicates that this hypothetic process has run its course in Tzeltal.

This is a plausible account but an incomplete explanation. There remains to be explained the apparent correlation of the degree of polytypy and the size of the folk biological inventory (Table 1). Independent of the domestication of plants and animals, an elaboration of taxonomic hierarchy might serve as a more efficient means to mentally store a larger quantity of folk biological knowledge. It is presumably easier to learn and to remember a set of five terms—one naming a basic level taxon and the others naming binomially labeled subdivisions, such as pine, Ponderosa pine, white pine, lodgepole pine, and white-bark pine—than to learn the unrelated names of four genera—as in Sahaptin, ***tâp'as̆*** 'Ponderosa pine', ***pak'inâkaas*** 'white pine'[9], ***kalâmkalam*** 'lodgepole pine', and ***nanikaas̆*** 'white-bark pine'. Thus we might expect the use of binomials to increase rapidly beyond a certain threshold of basic level name expansion, and to continue to increase in proportion to the size of the total inventory of basic level terms. Such an interpretation fits the data of Table 1. However, we have not explained the expansion of knowledge which, by this hypothesis, gives rise to the increase in binomial naming. In fact, we might have predicted quite the opposite, that is, that hunter-gatherers should have the largest folk biological inventories, subsistence agriculturalists the next largest.

with modern urban dwellers having the smallest, in relation to the degree to which each system depends upon detailed, widely-shared knowledge of natural history. Thus binomial nomenclature, if functionally linked to the scope of a folk biological domain as hypothesized above, should be inversely correlated with this progression of modes of production. This seems not to be the case.

We would like to propose a possible resolution of this seeming contradiction. First, we believe it likely that hunter-gatherers will have smaller folk biological inventories than subsistence farmers in the same habitat. This accords with an otherwise curious fact that Kalahari San hunter-gatherers are *more selective* of the plants they use than nearby agricultural Bantu (Lee 1979:180). They can afford to be more selective because of their low population densities and high mobility. Subsistence farmers are subject to periodic crop failures (Colson 1979), at which times they are forced to rely on wild foods the hunting-gathering San consider inedible. Their sheer numbers force them to recognize a wider range of species as of potential use than is true of the San. If this hypothesis is correct, the increased reliance on binomial naming by agriculturalists may be understood as a response to the need for an expanded ethnobiological repertoire. Brown (1984) has recently arrived at precisely this conclusion on the basis of an extensive series of cross-language comparisons.

Subsequent industrialization and urbanization reduces the need for detailed knowledge of natural species among the general population. As a consequence, the sweeping generality of life-form categories proves adequate in most circumstances. Binomial nomenclature, however, does not disappear, since the *cultivars* frequently so named remain important. Thus the elaborate taxonomic hierarchy proposed by Berlin as the ultimate expression of our evolving capacity to comprehend natural diversity is seen rather to result from a sequence of economic developments affecting our *need to know* aspects of that natural diversity (cf. Hunn 1982).

ACKNOWLEDGEMENTS

E. Hunn's research has been supported by NSF Grant BNS7616914 and by grants from the Melville and Elizabeth Jacobs Research Fund. D. French's research has been supported in part by a PHS research grant, GM-11287, from the National Institute of General Medical Sciences. Student assistance was supported by grants to Reed College under the Shell Assists program and the National Science Foundation (GY-4746, GU-3364). French would like to thank the Wenner-Gren Foundation, Carl N. Reynolds, the Social Science Research Council, and the American Philosophical Society for earlier aid, and Nancy Fowler and Kathrine S. French for a critical reading of the manuscript. Terence E. Hays and Paul M. Taylor provided most helpful critical comments. This work would not have been possible without the generous instruction, advice, and encouragement of our Sahaptin-speaking consultants. We dedicate our efforts to honoring their cultural achievements.

LITERATURE CITED

BERLIN, BRENT. 1972. Speculations on the Growth of Ethnobotanical Nomenclature. Lang. and Soc. 1:63-98.

———. 1973. Folk Systematics in Relation to Biological Classification and Nomenclature. Annu. Rev. Ecol. Syst. 4:259-271.

———. 1976. The Concept of Rank in Ethnobiological Classification: Some Evidence froms Aguaruna Folk Botany. Amer. Ethnol. 3:381-399.

BERLIN, BRENT, DENNIS E. BREEDLOVE, and PETER H. RAVEN. 1973. General Principles of Classification and Nomenclature in Folk Biology. Amer. Anthro. 75:214-242.

———. 1974. Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-Speaking Community of Highland Chiapas. Academic Press, New York.

BRIGHT, JANE O., and WILLIAM BRIGHT. 1965. Semantic Structures in Northwest California and the Sapir-Whorf Hypothe-

LITERATURE CITED (continued)

sis. Amer. Anthro. 67(5), Part 2 (Special Publication): 249-258.

BROWN, CECIL H. 1977. Folk Botanical Life Forms: Their University and Growth. Amer. Anthro. 79:317-342.

———. 1979. Folk Zoological Life Forms: Their University and Growth. Amer. Anthro. 81:791-817.

———. 1985. Mode of Subsistence and Folk Biological Taxonomy. Cur. Anthro. 26(1). Forthcoming.

BROWN, CECIL H., JOHN KILAR, BARBARA J. TORREY, TIPAWAN TRUONG-QUANG, and PHILLIP VOLKMAN. 1976. Some General Principles of Biological and Non-Biological Folk Classification. Amer. Ethnol. 3:73-85.

BRUNEL, GILLES. 1974. Variation in Quechua Folk Biology. Unpubl. Ph.D. dissert. (Anthrop.), Univ. California, Berkeley.

BULMER, RALPH N. H. 1974. Folk Biology in the New Guinea Highlands. Soc. Sci. Inform. 13:9-28.

COLSON, ELIZABETH. 1979. In Good Years and in Bad: Food Strategies of Self-Reliant Societies. J. Anthrop. Res. 35:18-29.

CONKLIN, HAROLD C. 1954. The Relation of Hanunóo Culture to the Plant World. Unpubl. Ph.D. dissert. (Anthrop.), Yale Univ., New Haven, Connecticut.

———. 1962. Lexicographical Treatment of Folk Taxonomies. International J. of Amer. Ling. 28(2), Part 4:119-141.

CURTIS, EDWARD S. 1911. The North American Indian. Volume 7. The Plimpton Press, Norwood, Massachusetts.

DOUGHERTY, JANET W. D. 1978. Salience and Relativity in Classification. Amer. Ethnol. 5:66-80.

DURKHEIM, EMILE, and MARCEL MAUSS. 1963. Primitive Classification. Translated and edited by Rodney Needham. University of Chicago, Chicago. (Originally published 1903 in French.)

FRENCH, DAVID H. 1957. An Exploration of Wasco Ethnoscience. Pp. 224-226 *in* Amer. Philosophical Society Year Book 1956.

———. 1960. Taxonomic and Other Conceptual Processes. Paper presented to the Amer. Anthrop. Soc. Ann. Meeting, Minneapolis, Minnesota, November 1960.

———. 1981. Neglected Aspects of North American Ethnobotany. Canad. J. Botany. 59:2326-2330.

GEOGHEGAN, WILLIAM H. 1976. Polytypy in Folk Biological Taxonomies. Amer. Ethnol. 3:469-480.

GUNTHER, ERNA. 1973. Ethnobotany of Western Washington. Revised edition. Univ. Washington Press, Seattle.

HAINES, FRANCIS. 1938. The Northward Spread of Horses among the Plains Indians. Amer. Anthrop. 40:429-437.

HAYS, TERENCE E. 1974. Mauna: Explorations in Ndumba Ethnobotany. Unpubl. Ph.D. dissert. (Anthrop.), Univ. Washington, Seattle.

———. 1976. An Empirical Method for the Identification of Covert Categories in Ethnobiology. Amer. Ethnol. 3:489-507.

———. 1983. Ndumba Folk Biology and General Principles of Ethnobotanical Classifications and Nomenclature. Amer. Anthrop. 85:592-611.

HEADLAND, THOMAS N. 1983. An Ethnobotanical Anomaly: The Dearth of Binomial Specifics in a Folk Taxonomy of a Negrito Hunter-Gatherer Society in the Philippines. J. Ethnobiol. 3:109-120.

HEALEY, CHRISTOPHER. 1978-79. Taxonomic Rigidity in Folk Biological Classification: Some Examples from the Maring of New Guinea. Ethnomedizin 5:361-384.

HUNN, EUGENE S. 1975. The Tenejapa Tzeltal Version of the Animal Kingdom. Anthrop. Quarterly 48:14-30.

———. 1976. Toward a Perceptual Model of Folk Biological Classification. Amer. Ethnol. 3:508-524.

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

———. 1979. Sahaptin Fish Classification. Northwest Anthrop. Res. Notes 14:1-19.

———. 1980. Final Project Report to the National Science Foundation. Manuscript, Dept. Anthrop., Univ. Washington, Seattle.

———. 1982. The Utilitarian Factor in Folk Biological Classification. Amer. Anthrop. 84:830-847.

LITERATURE CITED (continued)

HUNN, EUGENE S., and DAVID H. FRENCH. 1981. *Lomatium:* A Key Resource for Columbia Plateau Native Subsistence. Northwest Science 55:87-94.

IRVING, LAURENCE. 1953. The Naming of Birds by Nunamiut Eskimo. Arctic 6:35-43.

JACOBS, MELVILLE. 1931. A Sketch of Northern Sahaptin Grammar. Univ. Washington Publ. Anthrop. 4:85-292.

JOHNSON-O'MALLEY, CONSORTIUM OF COMMITTEES OF REGION IV. 1977. Yakima Language Practical Dictionary. Toppenish, Washington. Prototype.

LANCY, DAVID and ANDREW STRATHERN. 1981. "Making Twos": Pairing as an Alternative to the Taxonomic Mode of Representation. Amer. Anthrop. 83:773-795.

LAWRENCE, BARBARA. 1968. Antiquity of Large Dogs in North America. Tebiwa 11:43-49.

LEE, RICHARD B. 1979. The !Kung San: Men, Women, and Work in a Foraging Society. Cambridge University Press, London.

LYONS, JOHN. 1977. Semantics. Two volumes. Cambridge University Press, Cambridge.

MARSHALL, ALAN G. 1977. Nez Perce Social Groups: An Ecological Interpretation. Unpubl. Ph.D. dissert. (Anthrop.) Washington State Univ., Pullman.

PANDOSY, M. C. 1862. Grammar and Dictionary of the Yakima Language. Translated by G. Gibbs and J. G. Shea. Cramoisy Press, New York.

PEATTIE, DONALD CULROSS. 1950. A Natural History of Western Trees. Bonanza Books, New York.

RANDALL, ROBERT A. 1976. How Tall is a Taxonomic Tree? Some Evidence for Dwarfism. Amer. Ethnol. 3:543-553.

RIGSBY, BRUCE J. n.d. Sahaptin Grammar. *In* Handbook of North American Indians: Language, I. Goddard, ed. Volume 16. Smithsonian Institution, Washington, D. C. In press.

TAYLOR, PAUL. 1982. Plant and Animal Nomenclature in the Tobelorese Language. *In* Halmahera dan Raja Ampat sebagai Kesatuan Yang Majemuk, E. Masinambow, ed. Bulletin LEKNAS, Tahun II, No. 3 (Special Edition). Jakarta, Indonesia.

WADDY, JULIE. 1982. Biological Classification from a Groote Eylandt Aborigine's Point of View. J. Ethnobiology 2:63-77.

NOTES

[1] Earlier versions of this paper were presented by Hunn to the 5th Annual Ethnobiology Conference in San Diego, California, April 1982, and by Hunn and French to the 17th International Conference on Salish and Neighboring Languages in Portland, Oregon, August 1982. The Sahaptin examples cited are primarily from Hunn's John Day and Umatilla data. French's Warm Springs Sahaptin data differ in detail but are supportive of all key conclusions.

[2] Sahaptin words are written in a phonemic orthography adapted from Rigby (n.d.) as follows: plain stops, and affricates are ***p, t, c, ƛ, č, k, kʷ, q, qʷ***; glottalized stops and affricates are ***p', t', c', λ', č', k', kʷ', q', qʷ'***; spirants are ***s, ɬ, š, x, xʷ, x̣, x̣ʷ***; sonorants are ***m, n, l, w, y***; laryngeals are ***h, ?***; and vowels are ***i, ii, ɨ, u, uu, a, aa***.

[3] For some consultants ***wiwlúwiwlu*** refers instead to a wild blueberry, *Vaccinium caespitosum* Michx.

[4] In Northwest Sahaptin dialects ***twiní*** 'tail' replaces ***wáɬ was***. Some speakers prefer ***qúyx̣*** 'white, animate' to ***pláš*** 'white, inanimate'.

[5] Our consultants are unsure as to the characteristics of ***t'uulnawalá*** agreeing that it is a snake-like lizard that 'jumps'. Some informants may apply the term to alligator lizards (two species of *Gerrhonotus*); others may have in mind the rare and local western whiptail *(Cnemidophorus occidentalis)*.

[6] Contemporary consultants assert the ***pápš*** is equivalent to very large individuals of *Pseudotsuga* or *Abies*, while ***patátwi*** refers to all others of these genera. This seems unlikely to represent the original classificatory situation and contradicts some facts of the contemporary situation, most notably

the fact that ***patátwi*** very clearly implies a prototype with the characteristics of *Abies*, to wit, highly aromatic foliage. This characteristic—and important uses contingent upon it—are not cited for ***pápi***

7 For some speakers the iris is ***nunaswáaku ł***, named after the mariposa lily *Calochortus macrocarpus* Dougl. The classificatory principle is the same, as *C. macrocarpus* is a valued winter emergency ration.

8 A form functionally parallel to Sahaptin ***-wáaku ł*** '-like' is used by speakers of the Wasco dialect of Upper Chinookan, but only to *describe,* not to *name* categories.

9 This term was not cited in previous discussions of Sahaptin tree terms as it is apparently restricted today to the Northwest dialects.

BOOK REVIEWS AND ABSTRACTS

After a year of writing letters to publishers, badgering friends to finish book reviews, and pounding out last minute abstracts myself, I am finally starting to learn my craft. The *Journal of Ethnobiology* is now on the review list of most major publishers of ethnobiological works. If any of our readers are interested in becoming reviewers, please send me your name, address, and preferred subject area. We will also welcome unsolicited reviews if you discover a book that you want to share with our readership. Significant works that have been in press for awhile but may have been missed the first time around, should also be considered.

–Charles H. Miksicek
Book Review Editor

Book Review

Fading Feast: A Compendium of Disappearing American Regional Foods. Raymond Sokolov. New York: E. P. Dutton, Inc., 1983. 276 pp., illus., $6.95, paperback.

Fading Feast is a delightful collection of twenty-four essays collected by gastro-ethnographer Raymond Sokolov, on a two year expedition sponsored by the American Museum of Natural History through the backwaters and byways of the American heartland. This Indiana Jones of the culinary set, sought out endangered dishes from Tillamook Cheddar to Terlingua Chile, Kosher Challah to Cajun *Boudin Blanc;* foods with regional flavor and ethnic identity. In our homogenized and mass-marketed culture, most of these traditional dishes are only reserved for family gatherings and seasonal feasts. Others are only found in gourmet and specialty shops.

Many of these regional specialties are losing out to their more commercially marketable cousins. The small Key Lime, also known as the Mexican Lime, has been replaced by the Tahitian Lime, actually a green lemon-hybrid with questionable parentage. Maine lowbush blueberries are far more difficult to harvest, process, and ship than the larger, hybrid highbush variety. The imported Japanese persimmon compares about as favorably to the native Hoosier species, as the bounceable tomato found in our local market stacks up to a Midwestern "Beefsteak" picked fresh from the vine. Olympia oysters mature more slowly and never get as large as the Pacific oyster borrowed from Japanese mariculture. The stronger-flavored, native black walnut has a much thicker shell than the commercial species imported from Persia. Virginia hams take much longer to smoke and age properly than the brine-cured, water-injected product available from our local packing houses. Other delicacies are just plain rare, such as the Michigan morel, La Jolla abalone, or Minnesota wild rice. Still others, like white lightning are downright illegal.

Perhaps the most sobering tales in **Fading Feast** deal with traditional delicacies that have been strangled by government regulations or competing business interests. The native salmon harvest in the Pacific Northwest has been severely impacted by commercial and sport fishing, the timber industry, and damming the wild streams. Western lamb, which has always been tainted by the cowboy-shepherd rivalry, is now being affected by government permit regulations that favor recreational vehicles over ranchers. Interstate shipment of gooseberries is strictly regulated because they are an alternate host for the white-pine blister rust. Department of Agriculture regulations on meats are so stringent that geese, with tenacious pin-features, have been replaced by turkeys as the Christmas bird, chicken has replaced squirrel in Brunswick stew, and you will never find a blackbird in Kentucky *Burgoo*.

You are what you eat is more than just a trite phrase. The food we eat is a reflection of our cultural heritage. Delicate, wafer-thin *piki* bread, made from blue corn grown with the proper ceremony, ground on a stone metate, and cooked on a red-hot *piki* stone is an elegant expression of everything that epitomizes traditional Hopi society. Black-eyed peas and rice express the ties of South Carolina *Gullah* culture to its African roots.

I have always felt that the more senses that are used in a learning experience, the stronger a lesson is learned. Each essay in **Fading Feast** is followed by a collection of traditional recipes that will tantalize the nose and palate.

A review of a "cookbook" may seem a little out of place in a "serious" scientific journal, and yet a regional feast has been an important part of most of the recent Ethnobiology Conferences. In San Diego we tasted an astounding variety of Japanese delicacies, in Oklahoma we feasted on buffalo, and in Tucson we sampled traditional Papago and Southwestern fare. After a Northwest Coast banquet that included baked salmon, smoked ooligan, and salmonberry sprouts, many of the participants at the Seattle conference wondered what next year's gathering in Boston would have to offer. It would seem only logical to open to the chapter of **Fading Feast** that describes a traditional New England clambake and start hunting for a cord of hardwood, a truckload of rockweed, bushels of clams, and dozens of eager volunteers. It would also seem appropriate to invite Raymond Sokolov as the after dinner speaker.

CHM

Book Review

Hoko River: A 2500 Year Old Fishing Camp on the Northwest Coast of North America. Edited by Dale R. Croes and Eric Blinman. Pullman: Washington State University Laboratory of Anthropology, Reports of Investigations, No. 58, 1980. xx+ 333 pp. illus., $9.50, paperback.

The Hoko River Site was a coastal fishing camp on the northern edge of the Olympic Peninsula in Washington State that was occupied about 2500 years ago. Like the well-known Ozette Village, Hoko River is a waterlogged site with excellent organic preservation due to the constantly wet, anaerobic environment. Faunal remains identified from the site include a vast array of mollusks, fish, birds, land mammals, and sea mammals. Botanical artifacts include basketry, cordage, wooden fishhooks, conical hats, wooden wedges, and wooden handles for hafting microliths. Pollen and non-artifactual plant macrofossils are also discussed. Information derived from the experimental replication and utilization of various artifact types is also presented.

Hoko River includes a fascinating section on Ethnohistory by Jenel Virden and Maureen Brinck-Lund which provides very useful historic and ethnographic background. Detailed analyses are provided for each artifact class. The methodology sections provide interesting insights into the problems and potentials of wet-site archaeology. Because much of the detailed data from Ozette Village is not as yet widely available, the comparative data included in **Hoko River** will prove invaluable to other wet-site archaeologists and paleoecologists.

Hoko River will make those paleoethnobiologists that are used to working with data from open sites with much poorer preservation, green with envy.

CHM

Book Review

Farming Practice in British Prehistory. Edited by Roger Mercer. Edinbrugh University Press, 1981. viii+ 245 pp., illus., 9.50 Pounds Sterling, paperback.

Farming Practice in British Prehistory is a collection of papers from a symposium held in honor of Robert Munro at the University of Edinburgh in 1980 on prehistoric farming and its relevance to modern agricultural problems. It begins with a brief history of agrarian society in the British Isles and an overview of modern British agriculture. Peter Fowler's chapter, "Wildscape to Landscape" provides data on prehistoric field systems derived from an analysis of aerial photography. Halliday, Hill, and Stevenson examine "Early Agriculture in Scotland". Sian Rees reports on prehistoric agricultural tools, including sickles, ards (Celtic plows), and brush hooks. P. Rowley-Conwy suggests that much of the northern European pollen data should be re-evaluated not in terms of the more traditional interpretation of slash and burn land clearance, but in favor of more extensive clearance and permanent field systems. He cites long-term yield data from experimental stations at Woburn and Rothamstead that show no reductions in the return from cereal crops after fifty years of continuous farming by traditional methods. Peter Reynolds discusses the results of three research projects at the Butser Iron Age Farm, dealing with experimentally replicated and utilized ards, the yields of prehistoric grain types- emmer and spelt wheat, and the competition between field weeds and crops. (I have often wondered why Reynolds' book, *Iron Age Farm: The Butser Experiment*, has not received more attention in the American literature on experimental archaeology.) Gordon Hillman presents guidelines for interpreting crop husbandry practices from the charred remains of cereals and associated weeds recovered from archaeological sites. A. J. Legge focuses on Iron Age cattle husbandry. Michael Ryder reports on skins, fleece, and other important products from prehistoric livestock. Alexander Fenton discusses another significant animal product, manure which was critical to maintaining the high yields reported in earlier chapters.

Although the specific geographic focus of this research is the British Isles, and more generally temperate Europe; the data, models, and methods presented in this volume will be of interest to any investigator studying traditional agricultural problems.

CHM

REFERENCE CITED

Reynolds, Peter J. 1979. *Iron-Age Farm: The Butser Experiment.* London: British Museum Publications, Ltd.

RAYMOND MAURICE GILMORE
1 January 1907 – 31 December 1983

Photograph: Mike Hatchimonji, Los Angeles County Museum of Natural History

Ray Gilmore leading a whale-watching expedition.

On 31 December 1983, the San Diego community lost one of its most notable and well-loved scientists, Dr. Raymond M. Gilmore. His sudden death on the eve of his 77th birthday occurred as he was about to lead a whale-watching boat excursion. Throughout his life, Ray was a person who epitomized enthusiasm, energy, and thoughtfulness. He was both an engaging storyteller and a precise lecturer. An ethnobiologist before the word came into vogue, he ignored academic boundaries. Scarcely any subject in natural history and anthropology seemed to escape his scrutiny. His 65 published popular and scientific papers cover the subjects of descriptive taxonomy, zooarchaeology, epidemiology, and marine mammal studies.

Ray Gilmore took his A.B. and M.A. in zoology and anthropology at the University of California, Berkeley. During summers he collected birds and mammals extensively in California, Arizona, Nevada, Idaho, and Alaska. He spent one summer excavating Santa Cruz Islands shellmounds off Santa Barbara.

After a year as Ranger Naturalist at Yosemite, Ray went to Harvard in 1934 for doctoral studies as a Gibbs Fellow. At the end of the following summer he was invited by the Rockefeller Foundation to join a team of 65 scientists for a two and a half year stint in Brazil studying yellow fever epidemiology. Except for a brief period back in the States to marry Elizabeth Cotter of the American Museum and to complete his Ph.D. at Cornell University (Ithaca was his birthplace), Ray was to spend most of his time until late 1944 with the Institute of Inter-American Affairs studying yellow fever, malaria, typhus, and sylvatic plague in Brazil, Colombia, Peru, Boliva, and Ecuador. In the tropics he built treetop platforms to live-trap canopy animals for blood samples and he collected skins and skeletons for United States museums. Always inquisitive and thorough, he kept voluminous notes on the animals he handled, even drawing wing shpes and making color sketches of their soft parts. In the rubber collecting area of northeast Bolivia he built two hospitals and commissioned medical boats to attend to the needs of the scattered rubber gatherers.

Photograph courtesy of Mrs. Raymond Gilmore

Ray Gilmore during his epidemeological studies in Matto Grosso, Brazil, in the 1930s.

Both his master's and doctoral theses dealt with Bering Sea area mammalian biogeography in relation to glaciation. During the summer of 1931 he lived and trapped with St. Lawrence Island Eskimos. A spin-off of this research was Ray's continuing interest in the peopling of the New World and the dating of Early Man sites.

In late 1944 Ray went to the Smithsonian Institution as Associate Curator of Mammals. One of his jobs was to sort through 20,000 archaeological mammal bones. He published four important papers on zooarchaeology. Two were concerned with specific sites in Pennsylvania and the state of Coahuila, Mexico. Two others, one in *American Antiquity*, and the other in the *Journal of Mammalogy*, discussed the state of the art of faunal identification. In the latter, Ray wrote, "This type of work is considered by most identifiers to be an unmitigated drudge. There is also a desire on the part of the archaeologist to receive his identifications as soon as possible for his reports, with the result that the identifier's own work is interrupted." Some of his advice is just as appropriate today as when written in 1949. For instance, he recommended, "In preparing the report on the collection, mention can be made not only of the species present in the collection and the possible significance of their presence and abundance, but also of the species not found in the collection and the possible significance of their absence." He encouraged the permanent preservation and conspicuous marking of critical bones such as elements of species no longer found in the region. "This is an important point, because doubts as to one's own identifications of questionable and critical species always arise, and the pertinent bones will be desired in all good conscience for reexamination. They should be readily available."

With his many years of experience with South American biota and his background in zooarchaeology, Ray was a natural candidate to write "The Fauna and Ethnozoology of South America" for vol. 6 of Julian H. Steward's *Handbook of South American Indians* (1950, Smithsonian Institution).

From 1946 to 1958 Ray worked for the United States Fish and Wildlife Service, first in Washington, later at Scripps Institution of Oceanography, La Jolla, California. Ray's interest in whales, dolphins, and porpoises flowered during this period, an interest that occupied most of his own teaching and research for the next three and a half decades. In 1958 he became Research Associate in Marine Mammalogy at the San Diego Natural History Museum. The following year he led the first whale-watching boats to view gray whales off the San Diego coast. He took smaller tours to observe the Baja California calving lagoons of the grays in Scammons and San Ignacio Lagoons. Under National Science Foundation sponsorship in 1969 and again in 1970 he led teams of scientists into the Southern Hemisphere to survey marine mammals and birds. Each winter he entertained, in the best sense of the word, over 5,000 people on San Diego whale-watching tours.

A member of the Phi Sigma, Phi Beta Kappa, and Sigma Xi, Ray was also an honorary foreign member of the prestigious Venezuelan Socieded de Ciencias Naturales La Salle. He was an active member of the Committee on Polar Research, the National Research Council, and the National Academy of Science. When in 1982 the San Diego Museum of Man and the San Diego Natural History Museum co-sponsored the Fifth Annual Ethnobiology Conference, the local committee dedicated the conference in Ray Gilmore's honor.

Ray was no ordinary person, as anyone fortunate enough to know him will attest. During his academic years he was closely associated with some of the great names of this century such as Ales Hrdlicka, Joseph Grinnell, Alex Wetmore, Remmington Kellogg, Roy Chapman Andrews, Robert Cushman Murphy, Harry Swarth, the Kroebers, Carl O. Sauer, Carl Hubbs, and many others in the fields of anthropology, biology, and paleontology. An excellent storyteller, Ray had memorable anecdotes about them all. He assembled great files, *Neotoma* fashion, on these related subjects and seemed always able to help a student by providing references. His humor and vivacity are missed by all who knew him.

–Amadeo M. Rea
San Diego Natural History Museum

(For more detailed information, see *Environmental Southwest*, Spring 1984.)

NEWS AND COMMENTS

ETHNOBIOLOGY IN THE NEWS:

The Louisiana state Attorney General, William Guste, ruled on 29 November 1983 that alligators are *legally* fish. The ruling came in response to a request for a line of credit from the state Market Commission to alligator farmers. The existing statute failed to specify whether alligators fell within the scope of the definition of "livestock," and thus would be eligible for credit at the tax-payers' expense. "Livestock" encompassed "domesticated fish," which in turn, in Louisiana state law, included "all fish, crustaceans, frogs, turtles and other living aquatic resources which have sport or other economic value." Alligators, by Guste's ruling, are aquatic resources and thus domestic fish/livestock under the law. If this smacks of Linnean revisionism, consider that Mr. Guste in 1974 ruled cock fighting legal, since roosters, having only two legs, are excluded from the purview of the state's laws governing cruelty to animals. An animal, he noted, generally means "mammals or four-footed creatures." (From the University of Washington *Daily* of 1 December 1983.) Is there an employment opportunity here for a qualified consulting ethnobiologist with a specialty in folk classification?

REQUESTS FOR INFORMATION:

Darrell Posey, Director of the Laboratorio de Etnobiologia (a/c, Dept– de Biologia, Universidade Federal do Maranhao, 65.000 Sao Luis, MA, Brazil) writes that he has been commissioned to prepare a survey article on ethnoentomology for the *Annual Review of Entomology*. If you can help with reprints, references, or editorial suggestions please contact Mr. Posey.

Anton Saurwein (c/o Institut für Volkerkunde an der Universität München, Schellingstrasse 33, D-8000 Munchen 40, West Germany), editor of MEXICON: Aktuelle Informationen und Studien zu Mesoamerika, bimonthly journal of the Internationale Gesellschaft für Mesoamerika-Forschung e.v., solicits reports on current archaeological, ethnohistorical and anthropological research as well as announcements of congresses, exhibitions and other events of interest to Mesoamerican scholars. To subscribe send $20 US (+ $3 US for airmail delivery) to Karl-Friedrich von Flemming, Katharinenstr. 20, D-1000 Berlin 37, West Germany.

SOCIETY OF ETHNOBIOLOGY T-SHIRTS:

Trish Flaster (523 N. Grant, Fort Collins, CO 80521) is in charge of the society's fledgling Apparel Division, offering for $8.00 US (plus mailing charges) an elegant T-shirt with our journal logo prominently displayed on a rich clay-toned background. A variety of sizes and styles for men and women are available. Be the first on your jogging route to sport this unique T-shirt design and support your society in the bargain.

KAYAPÕ ETHNOBIOLOGY SYMPOSIUM:

The Universidade Federal do Maranhão, São Luís, Maranhão state, Brazil, hosted a symposium on Kayapõ Indian ethnobiology as part of this year's Congresso Brazileiro de Zoologia. Dr. Darrell Posey writes of the symposium that, "It was a great experience. The first time—at least in Brazil—that Indians had been included in a scientific society as invited discussants." The program featured nine papers and four Kayapõ "debatadores," listed below:

Dr. William Overal, Head of Entomology, Museu Goeldi, Belém
 Topic: Importance of Social Insects to the Kayapõ
Dr. Warwick E. Kerr, Head of Biology, Univ. Federal do Maranhão
 Native methods of insect control used by the Kayapõ
Dr. João M. F. de Camargo, Dept– de Biologia, Univ. Fed. do Maranhão
 Knowledge of stingless bees by the Kayapõ
Dr. David Oren, Dept. of Ornithology, Museu Goeldi
 Ethno-ornithology of the Kayapõ
Dr. Alfred A. Jensen, UNICAMP (Bio. Dept.) & SIL
 Onomatopoea in Kayapõ Bird Names
Dr. Elaine Elisabetsky, Dept. Pharmacology, Univ. Fed. do Pará
 Animals and Concepts of Disease
Dr. Miguel Petrere, Jr., Dept– de Biologia, Univ. Fed. do Maranhão
 Ethno-icthyology and ethnoecology of the Gorotire Kayapõ

Dr. Anthony Anderson, Dept– de Botanica, Museu Gooldi
Management of secondary forests and forest islands
Dr. Darrell A. Posey, Laboratorío de Etnobiologia, UFMa
Ethnobiology as an integrative methodology for inter-disciplinary research

Kayapó specialists were: José Utè (ethnobotanist), Kwyrã Ká (ethnozoologist), Beptoopoop (shaman) and Tàkàk Kayapó (10 year old son of Kwyrã Kà)

EIGHTH ANNUAL ETHNOBIOLOGY CONFERENCE

The program and schedule for the Eighth Annual Ethnobiology Conference is now being developed. It will be held in the Boston, Massachusetts, area in Spring 1985. Details will be announced later. Tentative plans include symposia on zooarchaeology and New England ethnobiology, and optional field trips to the Plymouth Plantation and to laboratories and field stations to view collections.

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed doubled-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses,* i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Arizona State Museum
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

With Volume 3, Number 1, the editors of the *Journal of Ethnobiology* added a book review section. We welcome suggestions on books to review or actual reviews from the readership of the *Journal.* Please send suggestions, comments, or reviews to Charles H. Miksicek or Richard S. Felger, Office of Arid Lands Studies, University of Arizona, Tucson, Arizona 85721.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Steven D. Emslie, Department of Zoology, University of Florida, Gainesville, Florida 32611. Subscription rates are $25.00, institutional; $15.00 regular members, for U.S., Canada, and Mexico; foreign subscribers add $6.00. Write checks payable to *Journal of Ethnobiology.* Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

CONTENTS

Journal of Ethnobiology

VOLUME 4, NUMBER 2

DECEMBER 1984

Journal Organization

Journal of Ethnobiology is published semi-annually. Manuscripts for publication and information for the "News and Comments" section should be sent to the appropriate editor as explained on the inside back cover of this issue.

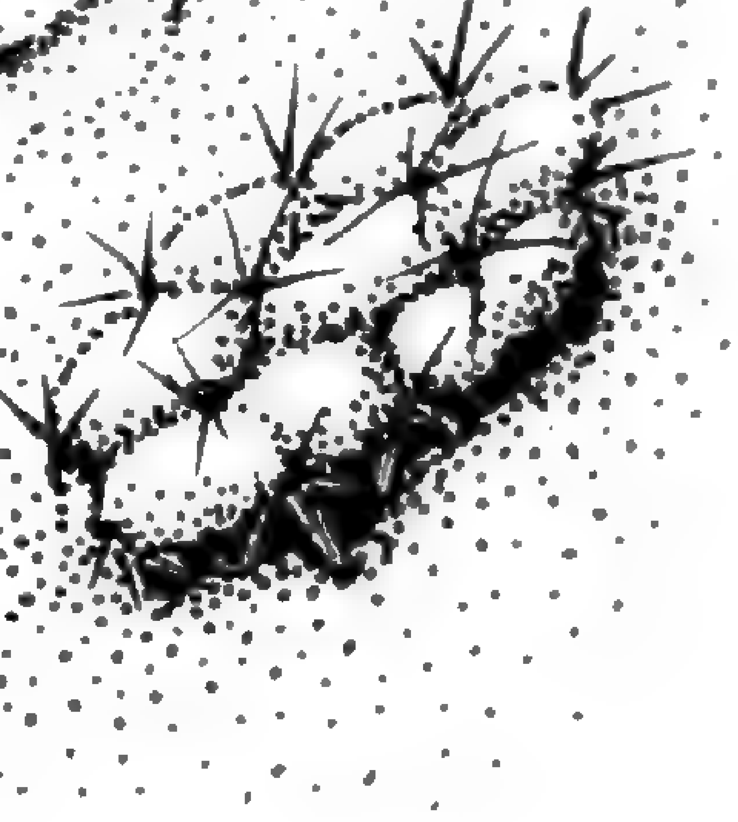
ISSN 0278-0771

Journal of Ethnobiology

VOLUME 4, NUMBER 2

DECEMBER 1984

SKETCHES IN THE SAND



It's early December as I write this and the Holiday Season is here—a time of anticipation, of reminiscing, and even of living in the present. In anticipation of the actual holidays, I distributed gifts of applebutter today and as I did so I indulged in recalling the apple harvest of bygone days and especially how apples were put away for winter use.

Many rural and even some town folks constructed and maintained root cellars and they were often as well supplied with winter stores as was the home of Mr. Badger in Kenneth Graham's classic tale, "The Wind in the Willows." In addition to carrots, turnips and parsnips, which are, botanically speaking, actually roots, Mr. Badger and rural folks of another era housed a number of other storables—some vaguely root-like, such as onions and potatoes, and others obviously not root-like at all, e.g. cabbages, quince, pears, and apples.

Nowhere do I read that Mr. Badger processed any of these foods, but the farm folks did. During inclement weather, they set aside large segments of a couple of days to shred dozens of heads of cabbage, to be layered in enormous stoneware crocks for fermenting into sauerkraut. On sunny, pleasant days, they made commodities such as applebutter in large cast iron, or preferably copper, kettles over an open fire.

Making sauerkraut required relatively little skill and various members of the farm family participated in its preparation. Making applebutter, on the other hand, required a great deal of skilled and constant attention and was relatively labor intensive. Usually the mother of the family supervised one or more of the younger children, who were too small to be useful in the fields, as they fetched wood and spelled her with the required constant stirring.

My mother made applebutter this way and for a number of years I was her assistant. I made many a trip to the woodpile to select a piece of wood of the proper size and type so that a fire of just the right amount of flame and heat would result. Also, I made many a second trip to the woodpile because my judgment in wood selecting was not as good as (or at least was different from) my mother's. And although I'm sure I complained under my breath, all the extra effort seemed worth it when enjoying that wonderful spread on hot biscuits on January mornings.

Eventually, of course, all the children grew up and left home. My father helped for a couple of years and then my mother modified her method for the kitchen, baking out the moisture in a slow oven. This works well, but several days are required for the same yield of a product that's not quite the same as was possible in one day out of doors. And, of course, with an electric or gas range, labor is considerably reduced.

I've made some modifications too. As we have come to appreciate fiber in our diets, I have eliminated paring the apples and put the apples, softened by cooking on top of the range, through a food processor before baking out the moisture in the oven.

I started making my mother's applebutter in 1976 in order to use the bushels of apples I impulsively bought at a roadside stand in Oak Creek Canyon, just south of

Flagstaff, Arizona. I gave much of the product to friends, who now each year make certain that I have apples with which to continue the tradition. It wasn't until several of us went on a camping trip that we had the pleasure of tasting applebutter with the true old-fashioned flavor that I recalled from childhood. As we sat around the camp fire each morning we kept the opened jar of applebutter near at hand. By the time the camping trip was over, the applebutter had acquired that slightly smokey flavor, just as it had in bygone days.

And at times late on a Sunday morning while savoring a tasty morsel generously covered with my favorite spread, I think of Mr. Badger and fantasize an interaction in the fashion of River Rat and Mole:

"What?" I cry, open-mouthed: "Never enjoyed applebutter! You've never–well, I–what have you been doing, then?"

"Is it so nice as all that?" asks Mr. Badger rather forcefully, though he is quite prepared to believe it as he surveys his bundles of dried herbs, nets of dried onions, baskets of eggs and assorted winter stores.

"Nice? It's the *only* thing," I say solemnly, as I open a jar of that essence of apple itself. "Believe me, my friend, there is *nothing* absolutely nothing–half so much worth spreading on biscuits as pure, unadulterated, old-fashioned applebutter!"

WY

J. Ethnobiol. 4(2):105-122 December 1984

"COVERT CATEGORIES" RECONSIDERED: IDENTIFYING UNLABELED CLASSES IN TOBELO FOLK BIOLOGICAL CLASSIFICATION

PAUL MICHAEL TAYLOR
Associate Curator of Asian Ethnology
Department of Anthropology
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560

ABSTRACT.–Covert categories can usefully be posited in the description of Tobelo folk biological classification in order to delimit the domain of investigation, to reflect groupings apparently referred to by Tobelo themselves, to provide "missing" superordinate classes for sets of co-hyponymous terms, and also to reflect those covert classes that must be posited for the description of lexemes in other domains. A review of methods generally used to posit covert classes, however, reveals that all are based on tests of perceived similarities among organisms. Such tests produce groupings that may be culturally irrelevant, that do not belong in a linguistic description, and that are based on similarities that may not be those used in hierarchically relating taxa. In order to avoid these difficulties, two alternative methods are tentatively proposed: "co-hyponymy," which identifies contrast sets lacking a superordinate term; and "definitional implication," which posits the covert classes in this domain required for the definitions of terms throughout the lexicon, based on a systematic review of vocabulary.

INTRODUCTION

Folk biological classification has proven to be one of the most culturally important and most exhaustively lexicalized areas of folk classification among pre-industrial peoples, reflecting those peoples' generally intimate familiarity with locally available fauna and flora. Although folk biological classification represents only one part of the subject matter of ethnobiology as a science, an ethnobiologist's concern with semantic and classificatory topics is justified primarily because decisions about the uses of plants and animals in subsistence, technology, medicine, and other areas of cultural endeavor are presumably based on criteria which can be linguistically expressed and discussed, and on a system of grouping local plants and animals into classes used in natural language (Taylor 1980a).

The great increase in research on folk biological classification systems over the past twenty years affirms the predominance of taxonomic relations among classes in ethnobiological domains, though folk biological taxonomies have admittedly also become notorious for irregularities of the sort enumerated by Ellen (1979:13): "multiple and interlocking hierarchies, extra-hierachic relations, synonymy, homonymy, polysemy, anomaly, covert categories and residual taxa." The distinctiveness of the "basic" or "generic" terms within those domains has also been widely reported, as has the observed fact that, if we consider only lexically labeled classes, folk biological classification systems seem to be universally "shallow" (having few taxonomic levels) but "wide," that is, having very large contrast sets, particularly among classes labeled by basic or generic terms (Berlin, Breedlove and Raven 1973).

While it is possible to present a description of a folk taxonomic system which includes only lexemically labeled classes, or even to define either "semantic classes" or systems of "classification" such that each class must be designated by a single lexeme (e.g. Conklin 1962:128), several cogent reasons have been offered for considering "covert" or unlabeled categories or classes within descriptions of folk taxonomies.

In a paper which inaugurated the study of covert categories in folk taxonomies, Berlin, Breedlove, and Raven (1968) emphasized that in attempting to identify covert categories of Tzeltal plants they adopted formal methods for uncovering categories which, though unlabeled, were recognized and used by natives. The inclusion of covert classes in a description of folk classification thus had the primary advantage of representing more precisely the shared set of structured relations among classes. Two further advantages of formally identifying covert classes were that (1) where the highest-level taxon or "unique beginner" is unlabeled a covert taxon can establish the domain of classificatory structures and (2) recognition of covert groupings of labeled classes could structure relations among the very wide contrast sets of basic ("generic") classes. Covert categories continue to be posited primarily in folk biological taxonomies, although the methods for positing them and the ontological or "psychological" status of the posited categories have been a subject of debate (Brown 1974 and reply by Berlin 1974; Hays 1976, Hunn 1976, 1977, Atran 1983).

In my own investigations of folk biological classification among the Tobelo (or "Tobelorese") people of Halmahera Island, Indonesia (Taylor 1980a, 1980b, 1982), I have also attempted to identify covert classes and have posited them using methods described below.[1] I have not, however, based my analysis on methods used by other authors (Berlin, Breedlove, and Raven 1968, Hays 1976, Hunn 1977). Though their methods differ, these all share the goal of identifying covert classes based on tests for *perceived similarity* among plant and animal classes. A critique of procedures designed to identify covert classes based on such tests will show that sometimes the only local cultural significance of those classes may be their sudden appearance as a result of tests designed to find them, that similiarities observed may not be those used in hierarchically relating folk taxa, and that such classes do not in any case belong in a linguistic description. It is not my purpose to argue that categories posited on the basis of such tests are necessarily worthless, only that their status as culturally recognized groupings of plant or animal classes is questionable, and that in any case they do not belong in a linguistic description of a semantic domain. Of course, much other interesting folk biological information (e.g. "symbolic" associations, medicinal and technological uses of folk taxa, techniques of cultivation, etc.) also does not belong in descriptions of semantic domains.

The two main techniques I have used in this study are derived from the two major areas of structural semantic investigation (Ikegami 1967:49, 60): (1) the description of the relations among lexemes in terms of their meanings, which leads to the method I call that of *co-hyponymy*, and (2) the description of the meaning of a single lexeme, which leads to the method I call *definitional implication*. The classes posited as a result of applying these methods to the Tobelo case are, at the very least, useful heuristic devices which point up relations among labeled classes in ways that the Tobelo themselves might recognize. At most, they represent covert classes used by the Tobelo themselves, comparable perhaps to similar classes used by other ethnic groups.

THE PROBLEM OF THE "UNIQUE BEGINNER"

Undoubtedly one of the most vexing problems for an ethnographer attempting to study folk classification of fauna and flora occurs when he discovers that, for speakers of many languages, no "unique beginner" or highest-level term exists (such as 'animal', 'plant', or 'living thing') which can define the domain of his investigation (Levi-Strauss 1966:1-2). Of course, it is possible to study plant and animal nomenclature by identifying the types of lexemes used to designate classes of all organisms that biologists consider "plants" or "animals." It is also possible to study man-plant or man-animal interactions without concerning oneself with the establishment of domains like "animal" or "plant" that have any relevance for the native speaker. But one cannot discuss "folk" classification—that is, the shared, structured set of relationships that members of a culture posit among those classes—without considering whether this assortment of terms for "plants and animals" names classes of objects grouped together or even considered similar by native speakers themselves.

The highest-level Tobelo terms designating classes of what we consider animals and plants ('animal', 'tree', 'herbaceous weed', etc.) have multiple senses, and there is no named higher-level "plant" class or named class of "living things." I have also been unable to find any distinctive grammatical treatments of plants or animals, although these can be found in some other languages. If we only consider lexically labeled classes in our study of Tobelo folk classification, we must content ourselves with one of two alternatives: (1) studying the relationship among those Tobelo classes which happen to contain objects biologists consider "biological"—and calling this the study of "Tobelo" ethnobiological classification, or (2) considering each highest-level term in the language—including 'tree', 'vine', 'rice', and many "basic" classes—a separate "unique beginner" establishing a separate domain. The serious problems with either alternative leave us no recourse except to posit covert higher-level classes, for the following reasons:

(1) The first alternative is adopted in one of its forms by Hunn (1977) and implicitly conceded by many ethnobiological studies which delimit the subject-matter of "folk" biology as the range of "folk" ideas about the subject matter of our Western biological science (i.e. the animal and plant kingdoms). But any analysis which claims to be "semantic" or to study meanings of terms and relationships among native classes cannot take as its point of departure a class whose membership is based entirely on a translation from another language or system of thought. To do so in this case would risk analyzing relationships among "native" ideational forms collected together in a way which is foreign to Tobelo language and culture.

Hunn (1977:44), however, argues that since the choice of a "unique beginner" is "arbitrary," we might as well use the domain of Western biology to investigate folk concepts of plants or animals. We can, of course, investigate classification of objects grouped together on any analyst's criterion, whether we take as our domain the set of all "animals and plants" or the set of all "objects smaller than a breadbox," if we consider such study useful. But we would have to leave aside any claim that such a grouping forms a culturally significant unit or domain to the "natives" whose classification system is under study. And the terms within such a domain can hardly be said to "contrast," since most definitions of semantic contrast (e.g. Conklin 1962, cf. Kay 1971) refer to contrast among subclasses of a *semantic* (not an "arbitrary" or contrived) class.

(2) The second alternative—considering each highest-level term in the language a separate domain of investigation—is not acceptable *in the Tobelo case* for four reasons, which may be listed in order:

1. The Tobelo themselves, as has been reported for many other cultures, seem to refer to groupings at levels higher than those labeled in the folk taxonomy. In the area of what we consider "plants," for example, there are minimally the named groups of 'tree', 'vine', and 'herbaceous weed', and also there are over 80 "basic" classes (having over 200 "terminal" or lowest-level subclasses) which are unaffiliated with these major plant groups. Yet Tobelo refer to groupings of such plants in everyday discourse. Thus an unfamiliar or distant bamboo can be denoted a ***boka o tiba-oli*** '(an object) rather like a ***tiba*** *(Schizostachyum* spp.; a bamboo)'. This whole phrase is sometimes substituted in sentences for the name of some particular bamboo species, or even used to refer to more than one species. Such regular non-lexemic phrases might be considered evidence for the existence of a covert class; that is, the phrase in this example may be a non-lexemic reali-

zation of the covert BAMBOO class.[2] While this is an important argument for the existence of covert classes, it is not reliable—in the Tobelo case—as a method of finding or positing them, since similar phrases ('rather like an X') are frequently made up for special purposes and without reference to generally used covert classes.

2. A second frequently-cited argument for positing covert classes has produced methods which will be criticized below; this is the argument of perceived similarity among classes, and it may briefly be paraphrased here. There are, after all, so many similarities among classes not grouped together under any higher-level term that we would expect those similarities to be conceptually recognized in any system of classification. Continuing the above example, the various labeled species of what we call "bamboo" are more like each other than like 'rice', 'sugar palm', 'cycad', and the other basic plant classes with which they seem to contrast. This similarity is recognized in biology and seems so obvious that it must be clear to folk classifiers, and could underlie local references to higher-level groupings noted above. It has been argued, therefore, that our analysis should posit covert classes like BAMBOO based on *tests* for this perceived similarity.

Though they suggest that positing covert classes could be worthwhile, both these arguments are hardly sufficient reason in themselves to posit such classes. Nor do they provide techniques for reliably delimiting the boundaries of those classes, as the critique below will argue. There are, however, two other reasons for considering that covert classes can be posited for Tobelo BIOTIC FORMS—and that they are required by the data:

3. Polysemous terms which form a contrast set in one of their senses are "co-hyponyms" (Lyons 1977:291) and must be considered contrasting subclasses of a higher-level class. It will be shown below that polysemous Tobelo terms for 'tree', 'vine', and 'herbaceous weed' form a co-hyponymous contrast set in one of their senses. This implies that they are immediate subclasses of an unlabeled higher-level domain, which we can call the PLANT or FLORAL FORM domain. Though these facts do not delimit the boundaries of any such FLORAL FORM domain, they do indicate that any analysis of these data *must* posit such a domain containing (minimally) these three named subclasses.

4. Finally, the method of "definitional implication" which I outline in detail below can be justified by recognizing that an adequate description of Tobelo animal or plant classification is only part of the larger task of describing the entire Tobelo lexicon. Many Tobelo words which are not names for animals or plants nevertheless have classes of biotic forms *implied* in the definitions of those words. We can use these related words to posit the covert classes implied in those definitions. It may be more parsimonious to posit a set of covert classes and then use them in the definition of "related" terms, than to independently define the set of objects to which each of those "related" terms may apply. Thus we may conclude that, though positing covert classes may seem to violate the requirement of parsimony in a linguistic description, it is not only required by the data, but may also be the more parsimonious path to a complete description of lexical structure within the language.

"COVERT CATEGORIES" AND THE PERCEIVED SIMILARITY OF FOLK TAXA

Because confining their analysis of a folk taxonomy to lexically labeled categories would have been too restrictive, Berlin, Breedlove, and Raven (1968) suggested techniques for discovering "many meaningful and culturally revealing categories related by inclusion that are not conventionally, monolexemically labeled" (1968:209). With the exception of evidence for the "unique beginner" PLANT class drawn from a distinctive Tzeltal numeral classifier used only for members of this domain, all the techniques were based on tests for locally perceived similarities among organisms.

We can consider the covert class within a description of language in the light of the normal relation between a linguistic sign and the objects that it denotes. This is often expressed as a triadic relation or "triangle of signification" (Lyons 1977:96-99; cf. Ogden and Richards 1923:11), in which the three angles A, B, and C of a triangle represent (A) the linguistic *sign*, e.g. a lexeme, and (C) the *object* denoted by that sign, which are mediated in some sense by (B) some concept of the *class* of objects which may properly be denoted by the sign. "The members of any naturally conceived class of things, arrived at pragmatically by stimulus generatlization, have some distinctive quality or combination of qualities in common, that furnishes the basis for their common designation" (Scheffler and Lounsbury 1971:4). Those distinctive qualities of a natural class are "the *significant features* of the objects and the *defining features* of the class". Following Scheffler and Lounsbury's (1971:3-6) terminology, we may say that the sign *denotes* the object or objects, and at the same time *designates* the class of such objects, and *signifies* the defining features of the class. From this perspective we can see that, in order to integrate covert classes into the classification systems we describe, and to treat them alongside labeled classes (i.e. taxa) in a hierarchically arranged classification scheme, we must have all the elements of the "triangle of signification" *except* the linguistic sign. Alternatively we may insist on finding some non-lexemic phrase or expression used to refer to the covert class, and consider that to be the sign, functioning like a lexeme to denote members of the class and to designate the class. In either case, we should recognize the need for distinctive features if we wish to integrate such a class into the same taxonomic model used for labeled taxa.

One alternative to this view is presented by Hunn, who prefers to consider the folk taxon "a set of real objects, in the present case, a set of animal organisms" (Hunn 1977: 42), rather than the class of those objects. The taxon or class, however, is not the same as its members; by Hunn's definition, every time a housefly anywhere dies or is born the taxon (rather than its membership) changes! We do not define the English-language taxon *housefly* by this shifting set of organisms which are the temporary members of the class, but rather by the constant attributes (or "features") of that class itself.[3]

Berlin, Breedlove and Raven (1968) however, recognize the importance of discovering distinctive features in positing covert categories. They commendably combine tests of perceived similarity among organisms with tests to determine whether distinctive features can be found to define the classes posited. The two major techniques used to determine candidates for covert categories are (1) card sorting, and (2) tests of triads, both of which test the informant's (native consultant's) perceived similarity among organisms. In the card sorting technique, names of labeled plant classes are written on separate pieces of paper and informants are instructed to group them together. As Atran (1983: 58) has pointed out, this method of elicitation seems designed to find only taxonomic relations, because only names of plant classes *within* the higher-level ("life form") classes are presented to the informant. "Thus, the method of elicitation may have unduly restricted recognition of complexes only to those which happened to fall entirely within the range of a given life-form" (Atran 1983:58). Furthermore, as Brown (1974:327) notes of both sorting tests and triads tests, "Such tests often present informants with culturally irrelevant options coercing them to sort items together which they rarely, if ever, group together on an ordinary *day to day basis.* Such groupings can hardly be considered culturally relevant." Brown also argues that many of the unlabeled groupings of plants and animals which can result from such tests are not covert classes at all, but labeled, culturally recognized categories which cross-cut the folk biological taxonomy. Atran (1983:55-56) cites examples from the Bunaq of Timor (Friedberg 1970; see also Friedberg 1979) and the Brou of Cambodia (Matras and Martin 1972) to illustrate that cross-cutting classifications relating to cosmology, cultural usefulness, or ecological affinities between plants may intersect the proper folk taxonomy under study. In short, the major problem with using sorting tests to determine folk taxa is that one can never be sure that the principles on which the sorting task is carried out correspond to culturally relevant principles used in hierarchically relating semantic classes. In using a card-sorting technique to investigate Navajo principles of classification, for example, Perchonok and Werner (1969) discovered that "people evidently felt no compulsion to use the same principle of classification consistently throughout the [taxonimic] tree," and that individuals not only differ in the classifications produced by this method, but also that they without exception "agree to the rightness of another person's classification, even though it differs considerably from their own" (1969:234), indicating that categories formed on the basis of such tests are not stable.

Hunn (1977:55) has correctly recognized that *perceived similarity* among such naturally diversified organisms as animals and plants is not just a simple matter of similarities among whole well-defined groups of classes ("covert categories"). Instead, he envisions handling this problem by recognizing that the degree of differences among named classes forms a continuum, which he proposes to represent by linking them into "chains" or "complexes". Such "chains" of organisms, in which *a* is linked to *b* and *b* is linked to *c* but *a* and *c* are not linked, are very difficult to reconcile with the notions of semantic class (or "concept") underlying the "triangle of signification" model of the relationship between a sign and its denotata, and thus must function very differently from the taxa discovered in the lexically labeled portion of the folk taxonomy, and should not be integrated with those taxa in the same model. Hunn gives the example (1977:55) of the 'slug' class, which is allegedly perceived by his informants to "link" the 'snail' class (or "complex") with that of the 'worm'. Though the three are not subclasses of any higher-level named class, this worm-slug-snail "chain" is allowed to creep into the posited taxonomy of named forms, leaving its trail of fragile posited link-ups so unlike the clear-cut taxonomic class-inclusion relationships which it and the other "chains" have infiltrated. If investigation of such "chains" may serve to give us more information about the way natives perceive or "feel about" these taxa, then they might usefully be included in ethnobiological studies alongside information on how the plants and animals are used, where they grow, how often natives see them, etc.—but all that information does not have to be forced into a description of the natives' classificatory system, alongside the clear relationships of class inclusion which are expressed (even if all those other things are not) in a folk taxonomy.[4]

We may also consider the use of "folk keys" constructed by informants as a technique to determine the distinctive features of categories posited on the basis of perceived similarity, (see e.g. Berlin *et al.* 1968:293). It is important to note that in folk as in biological keys more than one of these artificial arrangements of binary oppositions can be used to "key out" or arrive at the same set of items. More importantly, even if the keys did represent the way "folk" actually identify classes of organisms (that is, if the binary oppositions used, *and* the order in which they occur, were actually those natives used to identify objects), it still does not follow that the higher-order oppositions are those which form the most inclusive classes.

In biological systematics, where classification attempts to represent phylogenetic relationships among organisms, it is possible to write a "natural key" (Simpson 1961:15-16) in which the key first "keys out" higher-order taxa, then keys out the lower-order taxa in the order in which they subdivide the highest-level taxon. But most biologists who want to *use* keys to identify specimens would never bother with such a cumbersome arrangement (nor, probably, would folk classifiers).

Among the Tobelo—and I suspect others too—it seems that informants' stated reasons for grouping organisms together (whether for a folk key or for some other purpose) are often not really statements of the distinguishing features of that class, but rather "rules of thumb" (Goodenough 1951) which will be found not to hold true in all circumstances; just as an American asked to list the features of a "door" might give answers without taking "sliding doors" into account.

In natural conversations, Tobelo regularly wanted to figure out what kind of unfamiliar animal or plant was sighted by someone who did not recognize it. Where no hint was available except that it was a 'bird', for example, questions might involve the animal's behavior, time of day sighted, how it moved, and similar queries which clearly could not all be references to the distinctive features of the class, because, for example, a night bird (such as an owl) is still an owl at noon. If such queries are a guide to folk keys actually used, they bear much more resemblance to the multiple-approach keys sometimes included in field guides, in which oppositions need not be binary, the key need not key out all possible taxa, and an observer may key out specimens in more than one way with each of several types of key (see e.g. Fitter 1953:178-9). If such non-binary, multiple-approach keys represent one way Tobelo might identify specimens, as natural conversations indicate they might, then clearly folk keys constructed by informants may not be aimed at keying out taxonomic groups in their hierarchical order, but instead may, *if* properly representative of folk identification, only provide one of several ways natives identify specimens and place them in terminal or near-terminal classes in their taxonomy. An adequate folk key could yield interesting results for the study of folk identifications, but those results would still not constitute a classificatory structure such as a folk taxonomy.

Many of the same criticisms can be made for the "method of paired comparisons" used to identify covert classes, in which informants are requested "to compare all logical pairs of any set in terms of all the similarities and differences that he felt were relevant for any pair" (Berlin *et al.* 1968:293). As in the card-sorting techniques, the apparent lack of overlap cross-cutting higher taxonomic levels is possibly a result of the fact that paired comparisons are generally tested only *within* (not across) labeled taxa. In any case, we may suspect that, as with features found through construction of folk keys, features found by this means are quite different from the distinctive features used in componential definitions of labeled classes, because (1) informants' statements about similarity among members of a class often reflect "rules of thumb" rather than the features which actually discriminate the class; and (2) the features used and referred to most often are not necessarily those which are "judged important by the informant" for defining classes. In order to relate frequency of occurrence with importance for componential definitions, the technique requires that all the attributes distinguishing one class from another be equally "weighted" or distinctive (as well as equally likely to be verbalized), and thus that they can be compared by simply counting the number of times they are invoked in judging the dissimilarity of classes (cf. also Berlin *et al.* 1974: 61).

The assumption that native information-processing rules are like "natural keys," processing information about the taxa to which particular objects belong *in order* from the most inclusive to the least inclusive taxon, also underlies the method Hays (1976: 503) has introduced to identify covert classes in folk taxonomies:

> Assuming that my informants perceive their world and conceptualize it according to similar, though not identical, information-processing rules . . . much of the variability in their statements and acts is likely to be patterned in discoverable ways. I suggest that one of the patterns in plant naming responses is that, far from indicating random guesses, the diverse names offered tended to form relatively small sets whose members tended to co-occur regularly. Multiple instances of such co-occurrences, I propose, may be taken as evidence of conceived similarity among the categories designated by the names such that their tokens were readily "confused" with each other. . . . The categories as designated by these co-occurring names, then, may be considered conceptually grouped, whether the grouping itself is habitually named or not; when it is not, it may be referred to as a covert category or complex.

While Hays's methods commendably allow for a careful study of intra-cultural variation among informants in naming responses, his reliance on pressed voucher specimens in unnatural contexts probably greatly increased the variability of naming responses, because so little of the plant (excluding also its growth characteristics and habitat) was available for examination by informants. But even if these methodological problems could be surmounted, there is no evidence that information processing rules function like natural keys; if they function like non-natural keys the "co-occurrences" will not represent hierarchically-related groupings. In any case, understanding such information-processing rules would not help us describe language as a system (Saussure's *langue*) rather than as behavior *(parole)*.

A final argument for the existence of covert "mid-level" categories within folk taxonomies derives from the notion that man cannot store and process enough information at the same time to simultaneously consider contrast sets of large numbers of taxa such as those found in folk taxonomies. The argument follows Wallace's (1961) hypothesis which sets a limit of 64 items within a contrast set (Berlin *et al.* 1968:297). However, Wallace's (1961; cf. Miller 1956) limitation only concerns the storage and processing of information in short-term memory. Anyone can certainly imagine more ways to explain how Tobelo, for example, *might* "store and process" information about over three hundred basic classes which subdivide the Tobelo 'tree' class without stuffing them all into their short-term memories at the same time (note, for example, D'Andrade's n.d. notion of "cross-indexing" or the multiple-approach keys described above). Nor do informants need to consider at once the entire definition of any particular class. Not all the features used in defining a class need to be used to identify any particular member of the class. A type of 'tree' may be defined by characteristics of the bark, flower, leaves, etc.–but in fact the Tobelo and others can, for many kinds of 'tree', identify its leaves *or* its bark *or* its wood, without reference to the whole tree. Of course, as less information is available, misidentification becomes more likely.

In any case, a description of a particular semantic domain is part of the total description of a language, and language should be described in terms acceptable to some meta-theory of linguistics or semantics. Any adequate linguistic description risks presenting explanations that a psychologist, neurophysiologist, or cybernetician will have difficulty interpreting in the light of his specialization; but we need not choose one of his many possible interpretations and tailor our linguistic description to fit it. We should instead first describe language in linguistic terms, then consider relationships to other types of interpretation, rather than risk jumbling them together from the start.

Considering all the problems with the attempts to posit cover classes by testing for perceived similarities among classes, one might wish to simply ignore any unlabeled classes in the description of an ethnobiological domain. But for reasons stated in the preceding section we must still try to posit them, though with techniques other than those reviewed here. Any class so posited must have at least one distinctive feature which makes it acceptable as a semantic class, and which is shared by its subclasses.

CO-HYPONYMY

It was noted above that many of the highest-level terms in Tobelo folk biological classification have multiple senses. It is one of the tasks of anyone describing the Tobelo language to distinguish those senses of polysemous terms. If, however, we were to study only Tobelo "plant" classification separately from the larger task of describing the Tobelo language, we might ignore most other senses of terms like 'tree', 'vine', or 'herbaceous weed', and include in our analysis only those senses which occur in the domain of investigation. In order to illustrate how the study of polysemous terms can help us understand the folk classification system, several senses of the three highest-level Tobelo terms for "plant" (*o gota* 'tree', *o gumini* 'vine', and *o rurubu* 'herbaceous weed') are detailed below.[5]

(n. = noun; vb. = verb):

gota 1 n. 'tree' (including saplings) contrasts with ***gumini*** 1 'vine' and ***rurubu*** 1 'herbaceous weed' (excludes palms, cycads)

gota 2 n. 'relatively large tree' (excluding undergrowth of saplings) vs. ***rurubu*** 2 'weeds, unclutivated undergrowth' and various cultivated plants

gota 3 n. 'lumber' (wood from a ***gota*** 1 'tree' used for manufactures) contrasts with other materials of manufacture, e.g. ***katu*** 'thatch', ***paku*** 'nails', etc.

gota 4 n. 'firewood' vs. ***rage-rage*** 'kindling wood'

gota 5 n. 'woody tissue, wood' vs. ***kai*** 'bark', ***ngomaba*** 'throat (i.e. central steam tissue)', etc.

(i)-gota vb. 'to be woody, to have woody tissue' (from ***gota*** 5)

(bo-maa-)-gota-gota vb. 'to gather firewood' (from ***gota*** 4)

gumini 1 n. 'vine' vs. ***gota*** 1 'tree' and ***rurubu*** 1 'herbaceous weed'

gumini 2 n. 'rope'

rurubu 1 n. 'herbaceous weed' vs. ***gota*** 1 'tree' and ***gumini*** 1 'vine'

rurubu 2 n. 'weed, uncultivated undergrowth' (including 'tree' saplings, moss at the bases of small plants, vines growing among undergrowth etc.) vs. ***gota*** 2 and various cultivated plants

rurubu 3 n. 'thickness, density' (of hair, leaves, trees, undergrowth, houses, etc.)

-rurubu 1 vb. 'to be thick, dense' (from ***rurubu*** 3)

-rurubu 2 vb. 'to be full of undergrowth or weeds' (from ***rurubu*** 2)

One can easily find cases in natural Tobelo conversation where the same object may be denoted by two or more of these terms. For example, tree-like palm or cycad "trunks" may be called ***gota*** 4 'firewood', yet palms and cycads are *not* in the 'tree' (***gota*** 1) class. Similarly a Tobelo may refer to a small sapling as ***rurubu*** 2 'undergrowth' in the context of clearing fields, for example, whereas in a context in which he is looking for medicinal bark of that plant he may refer to the same sapling as a ***gota*** 1 'tree'. It is possible to have acceptable sentences like ***ma rurubu nenanga o gota*** 'this weed (***rurubu*** 2) is a tree (***gota*** 1); or said of the same sapling, ***nenanga o rurubuua, o gota bo*** 'this is not a herbaceous weed (***rurubu*** 1), it is a tree (***gota*** 1)'. If our informant then turned to the task of clearing the undergrowth and forest, we might hear him say of the same steadfast sapling, ***nenanga ma rurubu toparibobi, botino daba ma gota totoyanga*** 'Now I'll just cut down this undergrowth (***rurubu*** 2, including the sapling), later I'll cut down the trees (***gota*** 2). Without considering the polysemy of these terms and without recognizing that separate contrast-sets are being utilized, one might be puzzled by these superficially contradictory applications of terms.

Such examples of polysemous terms can be sorted out only by isolating the senses of those terms and noting the contrast-sets in which they occur. Where this can be done, as in this example of the contrast between ***gota*** 1, 'tree', ***gumini*** 1 'vine' and ***rurubu*** 1, 'herbaceous weed' it is possible to argue that, *in these senses,* the three terms are co-hyponyms; that is, that they are terms labeling contrasting subordinate classes which are included in some superordinate class. Lyons (1977:298) has noted that "lexical gaps" in English frequently occur in which terms seem to contrast but have no superordinate term in a taxonomy.

In cases such as that of 'tree', 'vine', and 'herbaceous weed' in the Tobelo language, we must posit a higher-level class, which we may call PLANT or FLORAL FORM, which has these senses of each of the Tobelo terms listed above as its subclasses. The method of co-hyponymy consists essentially of identifying a set of terms which can be shown to directly contrast in at least one of their senses, but which have no superordinate term to label the entire set. Having posited a FLORAL FORM domain by this method, we still have not resolved the problem of the boundaries of the domain, although it must minimally include the full range of the three subordinate terms on whose basis the FLORAL FORM class was posited. To more directly establish the boundary of the FLORAL FORM domain, we may turn to the method of "definitional implication."

DEFINITIONAL IMPLICATION

The method of "definitional implication", which is tentatively introduced here as a method for the determination of certain kinds of lexical domains, is based upon the assumption that the description of any set of lexemes in a language is only a part of the larger task of describing the entire lexicon of that language. In some cases, the description of certain lexemes requires positing covert classes of objects to which those lexemes are presumed to apply. Some of the Tobelo terms discussed below (such as 'male', 'female', or 'fat') seem to be partly defined by the classes of objects to which they are *presumed* to apply, and cannot be identified by any characteristics of objects properly labeled by the terms themselves.

The results of making these assumptions about positing unlabeled classes may be seen in Fig. 1. That diagram represents all the basic or "generic" terms within the posited BIOTIC FORM domain as if they were on the same *basic* (or B^O) level. This is consistent with the fact that the distinctiveness of these terms has long been recognized in folk biological nomenclature, and, though evidence for their distinctiveness cannot be detailed herein (see Taylor 1980b:244-252) it is possible to nomenclaturally distinguish Tobelo terms below the basic level (i.e. B^- terms) from terms at basic and higher levels (B^0 or B^+ terms). Levels below B^O are not represented in this diagram. The highest lexically labeled classes in the FLORAL FORM (or PLANT) domain are only at the B^{+1} level, while some FAUNAL FORMS are labeled two levels above the basic terms. The large numbers of named basic classes cannot be included on this diagram; the line extending to the right of most contrast sets of basic terms, and the dots following the examples listed, will substitute for the other basic terms not listed (there are, for example, approximately 146 basic classes of 'fish', though only two are listed). The significance of the broken line connecting the 'human being' (***o nyawa***) class to FAUNAL FORM will be discussed below.

Alinei (1974, cf. Taylor 1977), whose theory of lexical structure has suggested this view of a lexical domain (Alinei 1974:69-151), offers a systematic attempt to identify the underlying structure of lexemes in one domain in terms of sense-components drawn from the entire Italian lexicon. Unlike Alinei, however, I have here restricted the analysis of a particular domain to an example (BIOTIC FORM) established by a sense-component which is not itself realized by any lexeme in the language, although it is required in the

FIG. 1—Tobelo Classification of BIOTIC FORMS above the Basic (B^O) Level.

definition of other lexemes. I have further restricted the analysis to outlining the hyponymic relations of this posited BIOTIC FORM domain to other labeled and unlabeled classes within the domain.

It is clear from definitions of lexemes within folk taxonomies that a superordinate class may appear in the definition of subordinately related classes. Thus, for example, "bird" will probably have "animal" as a feature in its definition, just as "owl" and "robin" will probably have the notion of "bird" in their definitions. More importantly, "bird" will probably also be found in the definition of at least the primary senses of other words too. It is the implied class of subjects of verbs like *tweet* or *chirp* (compare *hoot* and its implied subject *owl*); it is also likely to be found in a definition of *beak*, *(to) perch*, or *feather*. If, in English, we happened to have names for the various types of bird (*robin, sparrow,* etc.) but no word for "bird", we could still posit a BIRD class because the occurrence of a sense-component BIRD in the definition of so many lexemes in English would allow us to posit a covert BIRD class implied in the definitions of those terms. It is more parsimonious to posit the class and then use it in those terms' definitions than it would be to repeat in each term's definition a more detailed statement of the class of objects (i.e., birds) to which each of those terms can apply.

Similarly, I have posited biotic classes apparently implied in the definitions of the rich Tobelo lexicon dealing with animal and plant forms. Ethnobiologists have often noted the wealth of terms applying to animals or plants, but have seldom used these to derive covert classes. In the case of Tobelo terms, I systematically reviewed all entries in Hueting's (1908) Tobelo-Dutch dictionary as well as my own data on terms relating to plants and animals, first with a key informant familiar with my semantic analyses, and later with other Tobelo at Kampung Pasir Putih (Jailolo District, Halmahera). We selected as potentially productive several hundred terms for plant and animal parts and products; for cutting, processing, cultivating, or handling plants, animals, or their products; for sounds or actions done by, or for characteristics of, plants or animals: in short, any terms that seemed related to living things and which might possibly contain some subclass of living things as part of their definition. These were quickly narrowed down to a small fraction of the number originally investigated, because rough attempts to develop componential definitions of such terms quickly indicated that it was not necessary to posit any covert classes in order to define most of the terms.

Ideally, sense-components within definitions in the Tobelo lexicon would be given using Tobelo lexemes for sense-components which are realized in the Tobelo language. Any metalanguage (including potentially one derived from Tobelo) could be used for those sense-components *not* directly realized in Tobelo. This goal of developing a fully "emic dictionary" remains extremely difficult for many practical reasons (Pawley 1970), although we can still analyze individual domains or portions of domains using assumptions that would make up such a dictionary.

Upon examination, the great majority of terms relating to plants and animals do *not*, when adequately defined, turn out to contain any classes of BIOTIC FORM in their definitions. It is important to emphasize that we should posit covert classes of objects in the definitions of terms only if alternative definitions cannot suffice to define the term in question. It is insufficient to argue that, because terms like 'leaf' or 'wing' apply only to plants or animals, they presume the existence of a PLANT or ANIMAL class. If those structures can be defined by reference to shape or function they do not require notions of PLANT or ANIMAL in the definition.

We may consider in order the four features or sense-components (living vs. non-living, sexual vs. non-sexual, breathing vs. non-breathing, and fatty vs. non-fatty) which allow us to posit covert classes above the B $^{+2}$ level, then we will consider the covert B $^{+1}$ classes of FLORAL FORM (or PLANT) implied in the definitions of other terms. No evidence has been found for positing covert subclasses of FAUNAL FORM.

1. *Living vs. Non-living* (+L vs. –L)

Organisms which may be said to 'live' (*-wango* 1) or 'die' (*-bonenge* 1) constitute the class of BIOTIC FORMS, the class of all organisms which are the implied subjects of 'live' and 'die', a class implied in the definition of these lexemes. Only this primary sense of the verbs 'live' and 'die' can be used in the participial form ***ma ngango*** 'living' or ***ma bonenge*** 'dead'. However, several other senses of these terms must be distinguished. Thus a motor or a fire may be said to *-wango* 2 'live' ('to run', 'to burn') or 'die' ('stop running' 'stop burning'), but the participial forms ***ma ngango*** 'living' and ***ma bonenge*** 'dead' can refer only to BIOTIC FORMS and *not* to these special cases. A disease or recurrent sickness, as well as any of over a dozen locally-named varieties of ***o tokata*** 'ghost' may be said to *-wango* 3 'act up, flare up' (i.e., be temporarily active), though the form *-bonenge* 'die' is not applied to the apparent disappearance of these entities and they may never be considered ***ma ngango*** 'living'. There is in addition another sense, *-wango* 4 'to grow (of its own accord without being planted)', contrasting with *-datomo* 'be planted, cultivated'. This is a special sense which again does not form the participial, and cultivated plants can of course be said to *-wango* 1 'live'. The class of BIOTIC FORMS may be posited as the highest-level covert class establishing the domain of investigation.

2. *Sexual vs. Non-sexual* (+S vs. –S)

A class of SEXUAL BIOTIC FORMS may be posited on the basis of the lexemes ***(ma) nauru*** 'male' and ***(ma) beka*** 'female'; that is, the class of SEXUAL BIOTIC FORMS contains all those BIOTIC FORMS expected to have 'male' and 'female' subclasses. It includes both FAUNAL and FLORAL forms, as well as 'seaweeds' and 'black coral'. Only ***o pabi*** 'coral', ***o gauku*** 'mushrooms and shelf fungi', ***o lulumiti*** 'moss, mould, bryozoa, smaller algae', and ***o tali ma kiarono*** '(certain) sponges' are not expected to possess this distinction. While the male-female distinction is recognized as one associated with mating and reproduction at least among ***aewani*** 'animals' (and, of course, humans), male and female plants are not considered to mate for reproduction. The local definitions of 'male' and 'female' do not coincide with a biologist's notion of sexual difference in animal and plant species; very often plants considered 'male' and 'female' forms of the same basic (B^o) folk class are from different botanical families (Taylor 1980a:224-225). Tobelo informants from several villages have volunteered the information that "all" 'trees', 'vines' and 'herbaceous weeds' have both 'male' and 'female' forms of each basic class though they were not familiar with all the male and female plant forms. In fact, however, basic plant classes whose 'male' and 'female' subclasses are *known* are far from the majority; informants also differ in their familiarity with the often esoteric knowledge of 'male' and 'female' forms. Among 'animals' (***aewani*** 1), Tobelo seem to assume there is mating and reproduction among 'male' and 'female' forms of each of these FAUNAL FORMS, and sometimes they are perceptive enough to recognize valid morphological signs of these organisms' sex (e.g. the widened abdominal segments on the undersides of female crabs). For most insects, worms, fish and other animals, however, they are quite at a loss to recognize whether any particular organism is in fact 'male' or 'female', though the presumption again is that there *must be* 'male' and 'female' forms.

3. *Beathing vs. Non-breathing* (+B vs. –B)

The BREATHERS, including all FLORAL and FAUNAL FORMS, form a subclass of SEXUAL BIOTIC FORMS defined by the ability to 'breathe' (*-womaba*). Ability to breathe implies possession of a 'throat' (***ma ngomaba***). Apparently considered the breathing organ, the ***ngomaba*** 'throat' refers to the esophagus and windpipe of vertebrates and to the esophagus of other animals, and to the stem cavities or the central core of stem tissue in vascular plants. It seems to be considered an organ of central importance to the survival of plants and animals.

I have tentatively noted (Fig. 1) the posited existence of a class of organisms, the NON-BREATHERS, which may contrast with BREATHERS as the subclass of all SEXUAL BIOTIC FORMS which cannot 'breathe' and have no 'throat'. This class, the most tentative of all those posited here, is not required by or implied in the definition of any lexeme. It unites seaweeds, sea grasses, and 'black coral'. All members of this class are plant-like organisms living attached in similar ways to the sea floor or to objects on the sea floor, and are considered to have 'male' and 'female' forms but to lack 'throats'. The Tobelo B $^{+1}$ term ***o rurubu o gabika*** 'seaweed' is anomalous in that it does not contrast with any other B $^{+1}$ term; it is also nomenclaturally anomalous and can be shown to be a recent introduction translating the North Moluccan Malay term *rumput laut* 'sea weed'.

4. *Fatty vs. Non-fatty* (+F vs. –F)

The Tobelo noun ***baki*** 'fat', and verb ***-baki*** 'to have fat' are other lexemes that seem to be defined partly by the class of objects presumed to possess them, and we may call that class FAUNAL FORMS. All ***aewani*** $_1$ 'animals' and ***bianga*** 'molluscs' are presumed to have ***baki*** 'the layer of substance occurring between the outer skin and the flesh of FAUNAL FORMS'—even those FAUNAL FORMS (such as tiny insects) which are too small for Tobelo to physically determine whether such a layer is present.

The BREATHERS which are not FAUNAL FORMS may be called the class of FLORAL FORMS (or PLANTS). We have seen that such a class must be posited because of the co-hyponymy of the contrast set 'tree'-'vine'-'herbaceous weed'. Several lexemes appear to be candidates for having the FLORAL FORM class in their definition, but perhaps the strongest would be the word ***utu*** which may be glossed 'the body or entirety of a PLANT on which a PLANT part is located'. Thus leaves, roots, flowers, etc., may be said to be ***ma utu-oka*** 'on the plant' (even though they are not on the main steam of the plant). No "part" of any loose branch, bamboo or wooden vessel, or of any non-FLORAL FORM such as mushroom or seaweed, or other object may be said to be ***ma utu-oka*** except parts of FLORAL FORMS. In this sense the term does not label a taxon or function like the noun ***aewani*** 'animal', but it is often correctly translated 'plant' in English. Thus to distinguish the 'tobacco plant' (***o tabako***) from the 'cigarette' (also ***o tabako***) Tobelorese may add ***ma utu*** 'its entirety of plant', i.e. "the plant."

To summarize the discussion of classes tentatively posited at the B $^{+3}$ level and above, we may offer componential definitions of the covert classes posited (Table 1). The fact that such definitions can be arrived at indicates that these are classes which *could* be used by the Tobelo themselves. All of these classes except the NON-BREATHER class were found necessary to posit in order to define lexemes in the Tobelo language. The NON-BREATHER class has so many distinctive features, and the separation of its 'seaweed' from its 'black coral' subclasses seems so atypical and probably intrusive, that the class has been posited here for those reasons. Because no such argument could be sustained for grouping together the asexual biotic forms into one class, the four "basic" classes having the features +L (living) and –S (non-sexual) have not been grouped into one posited class, and do not appear in this summary.

In addition to these classes at level B $^{+3}$ or higher, there is evidence for three covert classes of FLORAL FORM: BAMBOO, GRAIN, and PANDAN. Each of these covert classes has been observed lexicalized in some phrase of the form 'rather like an X', where 'X' is some particularly focal member of the covert class.

It should be noted that the form ***o bunga*** 'decorative flower', seen at the B^{+1} level in Figure 1, seems to be a recent intrusive term from Indonesian, just as the concept of

TABLE 1.—*Unlabeled Classes of Tobelo BIOTIC FORM Above B^{+2} Level*

Level	Unlabeled Class	Componential Definition			
B^{+6}	BIOTIC FORM	+L			
B^{+5}	SEXUAL BIOTIC FORM	+L	+S		
B^{+4}	BREATHER	+L	+S	+B	
B^{+4}	NON-BREATHER	+L	+S	–B	
B^{+3}	FAUNAL FORM	+L	+S	+B	+F
B^{+3}	FLORAL FORM (=PLANT)	+L	+S	+B	–F

planting and cultivating flowers around the home for purely decorative purposes is apparently a recent phenomenon. Although this term ***bunga*** is polysemous in Tobelo, it is apparently used to designate this subclass of FLORAL FORMS; thus it is not necessary to posit a covert DECORATIVE FLOWER class in this case.

The covert B $^{+1}$ classes of FLORAL FORM, along with the evidence for positing them, may now be considered:

1. BAMBOO

The posited BAMBOO class is lexically realized by the form ***boka o tiba-oli*** 'rather like a ***tiba*** (*Schizostachyum* sp.) bamboo', and includes ten basic (B^{0}) classes. Like the non-lexemic phrases which realize the other covert classes of FLORAL FORM, the phrase means "rather like" the most culturally important basic class of plants within the covert class.

The class must be posited because only the young shoots of members of this BAMBOO class may be termed ***o diburu*** (Dodinga dialect, cf. ***o jiburu*** in Boeng dialect of Tobelo). Thus this lexeme must be defined as 'young shoot of BAMBOO', and the covert class is implied in the definition of the lexeme. Hueting's (1908:22 and 325) Tobelo-Dutch dictionary lists the terms ***o badiku*** and ***o tabadiku***, which he notes are of Ternatese origin, and which he translates "bamboo, general name" and "bamboo" respectively. These words were unfamiliar to my Boeng and Dodinga dialect informants, however.

2. GRAIN

The "basic" class ***o pine*** 'rice' is subdivided into fifteen B^{-2} subclasses. Though undoubtedly others could be found if all villages were investigated specifically for 'rice' varieties, these represent all varieties known at my two field site villages (where rice is not a major staple). The only other known subclasses of GRAIN are ***o boteme*** 'Italian millet' (*Setaria italica* Beauv.), and ***o guapo*** 'sorghum' (*Sorghum bicolor* Moench). The GRAIN class may be realized by the phrase ***boka o pine-oli*** 'rather like rice'. It appears to be necessary to posit this class in order to define the term ***(ma) afa*** 'chaff of GRAIN'. Despite the large vocabulary associated with rice and millet cultivation, I found no other term requiring GRAIN in its definition.

3. PANDAN

PANDAN is here posited as a covert class, containing five basic classes of pandanaceous plants, because it is required in the definition of at least one of the terms used to describe the handling of pandanaceous leaves: ***-bakoto*** 'to gather PANDAN leaves'. The apparent lexical realization of this class is quite commonly used, i.e. 'rather like a ***bubo*** (*Pandanus* sp.)' (***bubo*** is the most culturally important form of pandanaceous plant). The verb ***-bakoto*** cannot even be used for the superficially similar action of gathering ***boboro*** (*Nipa* palm) leaves. As with the lexical realizations of other covert classes posited here, the phrase 'rather like an X' could hardly be considered sufficient evidence for the class if it were only used to describe other plants; instead, it is used as a noun to designate the whole class.

Before concluding, it is necessary to comment on the placement of the ***o nyawa*** 'human being' class within this scheme of Tobelo BIOTIC FORMS. Only this class stands out as having no basic ("generic") terms. If one considers (as I do not) that the purpose of positing higher-level covert classes is only to show the classificatory associations of all the basic terms in the domain, then we need not concern ourselves with the position of this class, since it is not labeled by a basic term. Because it seems in some contests to contrast with ***aewani*** $_1$ 'animal' we may tentatively place it at level B^{+2} in Fig. 1. In any case, these levels are only important insofar as they indicate relations of class inclusion among subclasses of BIOTIC FORM; no claim is made for particular characteristics of terms or classes at any level except the basic one, and presumably those who do make such claims for characteristics of particular levels (e.g. Berlin *et al.* 1973, Brown 1977, 1979) will have means of recognizing the levels to which their generalizations apply. Nevertheless, the 'human being' class does meet the defining features of the FAUNAL FORM class, and thus of all the superordinate classes, and must be included in this diagram and in our analysis for that reason. The broken line is used in Fig. 1 to indicate that, while included for those reasons, this 'human being' class is sufficiently different from other BIOTIC FORMS to be distinguished in that fashion on the diagram. With that addition, we may say that Figure 1 summarizes the posited relations among labeled and unlabeled classes that form the Tobelo system of classification of BIOTIC FORMS above the "basic" (or "generic") level.

CONCLUSION

This paper has criticized some methods for positing covert categories in folk classification, and introduced some others. In particular, the disadvantages of positing covert categories on the basis of tests for perceived similarity among organisms has been emphasized. Categories derived from such tests may prove useful in describing local perceptions about animals and plants, but cannot produce classes of the sort that belong in a linguistic description of a semantic domain.

By instead focusing on co-hyponymous contrast sets within folk taxonomies, and by examining a wide range of vocabulary items for classes implied in their definitions, it may be possible to avoid some of these difficulties. The methods of co-hyponymy and of definitional implication used here do produce classes that seem to have some "psychological reality" because they can be shown to underly lexemes used in the language under study. Nevertheless, it is also possible to consider them purely heuristic devices which may be used to *describe* locally perceived similarities among named animal and plant forms.

I prefer to consider the methods of co-hyponymy and definitional implication techniques for establishing a lexical field (cf. Lehrer 1974:15-45)—in the example considered here, the field of the BIOTIC FORM in Tobelo. The usefulness of the covert classes so posited depends primarily on their ability to assist in the description of the semantic relationships among labeled classes which divide up that field.

LITERATURE CITED

ALINEI, MARIO. 1974. La Struttura del Lessico. Il Mulino, Bologna.

ATRAN, SCOTT. 1983. Covert fragmenta and the origins of the botanical family. Man (N.S.) 18.1:51-71.

BERLIN, BRENT. 1974. Further notes on covert categories and folk taxonomies: a reply to Brown. Amer. Anthropol. 76: 327-331.

BERLIN, BRENT, DENNIS E. BREEDLOVE and PETER H. RAVEN. 1968. Covert categories and folk taxonomies. Amer. Anthropol. 70:290-299.

————. 1973. General principles of folk biological classification. Amer. Anthropol. 75:214-242.

————. 1974. Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-speaking Community in Highland Chiapas. Academic Press, New York.

BROWN, CECIL H. 1974. Unique beginners and covert categories in folk biological taxonomies. Amer. Anthropol. 76:325-327.

————. 1977. Folk botanical life-forms: their universality and growth. Amer. Anthropol. 79:317-342.

————. 1979. Folk zoological life-forms: their universality and growth. Amer. Anthropol. 81:791-817.

CONKLIN, HAROLD C. 1962. Lexicographical treatment of folk taxonomies. *In* Problems in lexicography: report of the conference of lexicography held at Indiana University, November 11-12, 1960. Internat. J. of Amer. Linguistics 28.2:119-141.

D'ANDRADE, R. G. n.d. [1962?]. [Aguacatenango Tzeltal ethnobotany]. Unpubl. MS.

ELLEN, ROY F. 1979. Introductory essay. Pp. 1-32., *in* Classifications in their Social Context (R.F. Ellen and D. Reason, eds.). Academic Press, New York.

FITTER, R. S. R. 1953. The Pocket Guide to British Birds. Dodd, Mead, New York.

FRIEDBERG, CLAUDINE. 1970. Analyse de quelques groupements de végétaux comme introduction à l'étude de la classification botanique Bunaq. Pp. 1092-1131. *In* Echanges et Communications: Mélanges Offerts à Claude Levi-Strauss à l'Occasion de son 60ème Anniversaire. (J. Pouillon and P. Maranda, eds.) Mouton, The Hague.

————. 1979. Socially significant plant species and their taxonomic position among the Bunaq of Central Timor. Pp. 81-101 *in* Classifications in their Social Context, (R.F. Ellen and D. Reason, eds.). Academic Press, New York.

GOODENOUGH, WARD H. 1951. Property, Kin, and Community on Truk. Yale Univ. Pub. in Anthropol. No. 46, New Haven.

HAYS, TERENCE E. 1976. An empirical method for the identification of covert categories in ethnobiology. Amer. Ethnol. 3:489-507.

HUETING, A. 1908. Tobeloreesch-Hollandsch Woordenboek met Hollandsche-Tobeloreesche Inhoudsopgave. Nijhoff, The Hague.

HUNN, EUGENE. 1976. Toward a perceptual model of folk biological classification. Amer. Ethnol. 3:508-524.

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

IKEGAMI, YOSHIHIKO. 1967. Structural semantics: a survey and problems. Linguistics 33:49-67.

KAY, PAUL. 1971. Taxonomy and semantic contrast. Language 47.4:866-887.

LEHRER, ADRIENNE. 1974. Semantic Fields and Lexical Structure. American Elsevier, New York.

LEVI-STRAUSS, CLAUDE. 1966. The Savage Mind. Univ. of Chicago, Chicago.

LYONS, JOHN. 1977. Semantics. Cambridge Univ. Press, Cambridge.

MATRAS, J., and M. MARTIN. 1972. Contribution à l'ethno-botanique des Brous (Cambodge—Province de Ratanakiri). J. d'Agriculture Tropicale et de Botanique Appliquée 19:1-49, 93-139.

MILLER, GEORGE A. 1956. The magical number seven, plus or minus two: some limits on our capacity of processing information. Psychol. Review 63:81-97.

OGDEN, C. K., and I. A. RICHARDS. 1923. The Meaning of Meaning. Routledge & Kegan Paul. London.

PAWLEY, ANDREW. 1970. Are emic dictionaries possible? Kivung 3.1:8-16.

PERCHONOK, JAMES and OSWALD WERNER. 1969. Navajo systems of classification: some implications for ethnoscience. Ethnology 8.3:229-242.

SCHEFFLER, HAROLD W. and FLOYD G. LOUNSBURY. 1971. A Study in Struc-

LITERATURE CITED (continued)

tural Semantics: The Siriono Kinship System. Prentice-Hall, Englewood Cliffs.

SIMPSON, GEORGE. 1961. Principles of Animal Taxonomy. Columbia Univ. Press, New York.

TAYLOR, PAUL MICHAEL. 1977. Review (of) La Struttura del Lessico (by) Mario Alinei. Amer. Anthropol. 79:704-5.

———. 1980a. Preliminary report on the ethnobiology of the Tobelorese of Halmahera, North Moluccas. Pp. 215-229, *in* Halmahera dan Raja Ampat: Konsep dan Strategi Penelitian (E. Masinambow, ed.) LEKNAS-LIPI, Jakarta.

———. 1980b. Tobelorese Ethnobiology: The Folk Classification of "Biotic Forms." Ph.D. dissert. (Anthrop.) Yale Univ., Univ. Microfilms No. 8109818.

———. 1982. Plant and animal nomenclature in the Tobelorese language. Pp. 41-76, *in* Halmahera dan Raja Ampat sebagai Kesatuan yang Majemuk. (E. Masinambow, ed.). Spec. ed. of Bulletin LEKNAS 2.1. LEKNAS-LIPI, Jakarta.

WALLACE, A. F. C. 1961. On being just complicated enough. Proc. of the Nat. Acad. of Sciences 47:458-464.

NOTES

1. This report is based on fieldwork totaling 33 months, carried out among the Tobelo of Halmahera Island during two field seasons. The first (October 1977-July 1979) was supported by a Fellowship for Doctoral Dissertation Research in Southeast Asia from the Social Science Research Council of New York, with an additional Research Grant from the Concilium of International and Area Studies (Yale University). A second field season (December 1980-November 1981) was supported by a grant from the National Geographic Society.

2. Posited covert classes will here be distinguished by being written in upper case letters (e.g., BAMBOO, BIOTIC FORM).

3. Hunn's argument against the use of distinctive features in this way is surprising (Hunn 1977:42 and footnote):

> . . . I reject the alternative approach to taxonomic axiomatization that would define taxa as sets of features. Such an approach is not consonant with the postulate that taxa are related to one another by set inclusion . . . [footnote:] If a taxon (*t*) is defined [by] . . . features (*a, b, c*), then a taxon (*t*-1) which is immediately included in the taxon (*t*) must be defined as a set of features (*a, b, c, d*). Thus *t*-1 cannot be a subset of *t*.

This argument seems to confuse the distinctive features used to define a class with the *members* of that class (or the *elements* of a set). In defining classes of English "kin", for example, we might define *parent* with features like (a) Kin, (b) First ascending generation, and (c) Lineal. *Father* would require a fourth feature, (d) Male. Yet *father* is clearly a subclass of *parent*.

4. Elsewhere Hunn (1976) has argued that such "chains" more accurately reflect perceived differences among organisms than can be reflected in the taxonomic model, and that taxonomic models do not distinguish between what he calls "deductively" and "inductively" defined categories (the former based on a small number of abstract features, the latter based on large numbers of naturally occurring shared characteristics). The aim of the semantic description of a domain is to describe the meaning of each linguistic form occurring in the domain and to describe the sense relationships of those forms to each other. Taxonomic principles are valuable insofar as they can be used to structure class-inclusion and contrast relations among linguistic forms, though they admittedly will not fully describe *perceptions about* the objects denoted by those forms. As for the numbers of features defining "categories," his interesting distinction between "inductively" and "deductively" defined categories does not make it less necessary to assert that the description of any semantic class should include at least one defining feature to distinguish that class from others in the domain.

5. This analysis of these polysemous terms and the ensuing discussion are from Taylor (1982), where the example was used to indicate the importance of distinguishing polysemous terms in nomenclature; here the example is brought up for a different purpose, to illustrate the method of co-hyponymy in positing covert classes.

J. Ethnobiol. 4(2): 123-139 December 1984

HIERARCHY AND UTILITY IN A FOLK BIOLOGICAL TAXONOMIC SYSTEM: PATTERNS IN CLASSIFICATION OF ARTHROPODS BY THE KAYAPO INDIANS OF BRAZIL[1]

DARRELL ADDISON POSEY
Laboratório de Etnobiologia
a/c Departamento de Biologia
Universidade Federal do Maranhão, 65.000 São Luís, Maranhão (Brazil)
and
Carnegie Museum of Natural History
Section of Man
5800 Baum Boulevard, Pittsburgh, Pennsylvania 15206 (U.S.A.)

ABSTRACT.–Kayapó Indian classification of insects and related Arthropods is characterized by named Basic Object Level (BOL) categories that recognize "natural discontinuities" in gross morphological form. Organization of BOL groupings is a continuum of overlapping or contiguous sets called "morphological sequences." Hierarchical structures emerge when BOL categories (or sequences) are of utilitarian and/or symbolic significance. Named subordinate differentiations are indicators of "utility;" named superordinate groupings are indicators of symbolic significance. Hierarchical structures are, therefore, indicative of utility, suggesting that current hierarchical and utilitarian models are not contradictory as assumed but rather complementary.

INTRODUCTION

Recent papers by Hayes (1982) and Hunn (1982) have attempted to provide a utilitarian/adaptionist framework for folk biological classification studies. Hunn (1982: 830) outlines a "fundamental contradiction" between his utilitarian "natural core model" and the traditional, formal hierarchy model of Berlin (1973, 1976) and Berlin, et al (1966, 1973). Hunn correctly points out that ethnobiologists have woefully ignored the practical, utilitarian aspects of folk classification; he is, however, unnecessarily polemic in his critique of hierarchical models.

This paper presents data to suggest that there is no "fundamental contradiction" between hierarchical and utilitarian models, but rather confusion between *process* of classification and *purpose* for classification. All societies classify some natural phenomena utilizing processes of culturally influenced categorization (cognitive categories) organized in logical patterns distinctive to that society (taxonomic structures). These processes can be studied as cognitive/perceptual phenomena (eg., Hunn 1976, Kay 1971, Rosch 1978) or as classificatory/logical phenomena (eg. Berlin, 1972, 1973, 1976; Brown 1977, 1979). The latter inevitably demonstrates hierarchical characteristics of ethnotaxonomic rank.

Description and analysis of classification processes, however, do not explain *why* in any given society certain natural domains are classified and named while others are not. This question is best investigated from the utilitarian/adaptionist approach.

Data in this paper show a correlation between the degree of subordinate differentiation (i.e., differentiation below the Basic Objective Level) and utilitarian significance. Superordinate categories (i.e., groupings above the Basic Object Level) are of two types: (1) named categories that appear to be indicators of epistemological (symbolic or mythological) significance, and (2) generally unnamed (covert) categories that reflect "chain-ing" (i.e., loose groupings based on perceived similarities in morphology, behavior or use). Utilitarian significance is therefore encoded at the subordinate level, while symbolic importance of a domain is signalled by named superordinate categories. Thus hierarchical structures in the Kayapó taxonomic system are indicative of "utility", either practical or symbolic.

BASIC OBJECT LEVEL FORMS AND MORPHOLOGICAL SEQUENCES

Data analyzed in this paper were collected in Gorotire, the largest of the northern Kayapó villages (7°48's, 54°46'w), in the Brazilian State of Para. Consult Posey (1979) for a detailed description of research design and methods used for folk taxonomic and ethnoentomological investigations.

For the Kayapó all visible things are divided into four categories: (1) things that move and grow, i.e., animals; (2) things that grow but do not move, i.e., plants; (3) things that neither move nor grow, i.e., minerals; and (4) humans—creatures that are akin to all animals, yet unique and more powerful than animals because of their social organization.

It is the first covert (unnamed) category of "animal" with which this paper is particularly concerned. All animals are sub-divided into two named groups: those with "flesh" (called ***mry***, or flesh), and those with "shells" and no flesh (called ***mry kati*** or no flesh).[2] This latter group, animals with shells and no flesh, coincides with the scientific phylum Arthropoda.

The most psychologically salient of the taxonomic units in the Kayapó ethnobiological classification system are Basic Object Level (BOL) categories. BOL categories reflect "natural discontinuities" in nature (cf. Hunn 1975, 1976, 1977) by classifying natural units characterized by variations in morphological forms. Other characteristics—such as color, sound, smell, texture, movement, etc.—may be simultaneously encoded, but general shape or form is the fundamental criterion for BOL discrimination.

As previously described (Posey 1981), four "morphological sequences" are found for ***mry kati (maja)*** in the Kayapó system. The term morphological sequence describes a continuum of morphological traits that unites a series of BOL categories. The sequence may be an uninterrupted continuum with overlapping members between contiguous BOL categories, or there may be interruptions in the continuum marked by an unusual (aberrant) morphological feature. Figure 1 illustrates the morphological sequences for the Kayapó system of Arthropod classification (numbers refer to BOL categories in Table 1).

The Kayapó system shows four types of BOL categories: (1) Focal Forms – specimen that are always classified in the same BOL category and are considered typical of that category. (2) Transitional Forms – specimen that are frequently classified in more than one BOL category, indicating shared morphological characteristics with other BOL groups. These are always members of the same "morphological sequence." (3) Aberrant Forms – specimen that are consistently classified in the same BOL category but are given special names because of distinctive morphological characteristics. These form subgroups of the BOL category. (4) Collective Forms – specimens too small to be classified based on morphological characteristics. Table 1 lists Kayapó BOL categories by form types and includes their scientific equivalents.

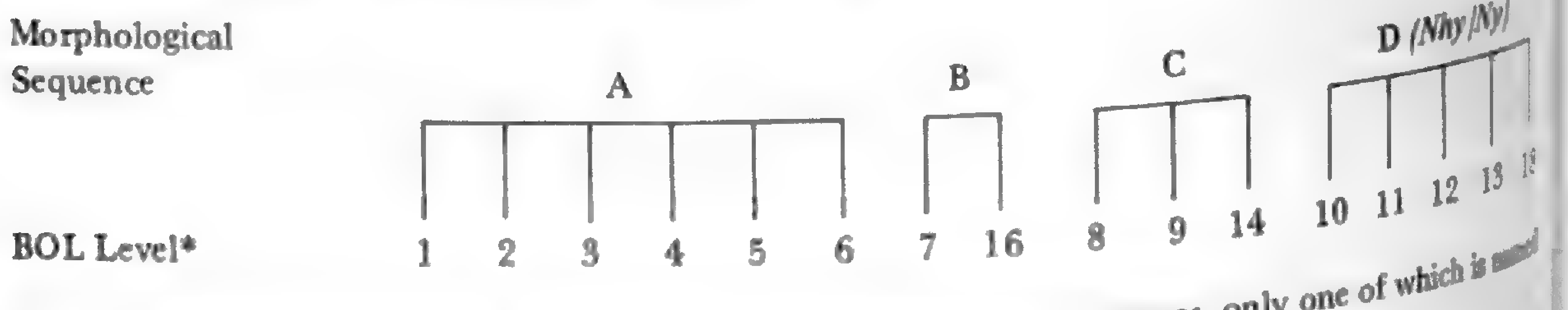


FIG. 1.–Organization of BOL categories into 4 morphological sequences, only one of which is named *(Nhy/Ñy)*.*

Named, "undifferentiated utilitarian categories" are also sometimes found that group animals of the same BOL category into a collective class because of their similar utilitarian significance. ***Kikre-kam-mãrã***, "house beetles," is an example in which all house "pests" that are beetles receive the same name, although morphologically they are said to be different.

TABLE 1.–Levels of correspondence for insects.

BOL Categories[1]	Common Name	Correspondence Levels	Correlation[2]
Focal Forms:			
(1) mãrã	beetle	Order (Coleoptera)	1:1
(2) ipoi	true bug	Order (Hemiptera)	1:1
(3) kapo	roach	(Family: Blattidae)	+
(4) krytkañet	grasshopper, cricket	Order (Orthoptera)	1:1
(5) wewe	butterfly, moth	(Various Orders)	–
(6) kañeñet	dragonfly	Order (Odonata)	1:1
(7) kokot	leafhopper, cicada	Order (Homoptera)	1:1
(8) pure	fly	Order (Diptera)	1:1
(9) kopre			
(10) rorot	termite	Order (Isoptera)	1:1
(11) mrum	ant	(Family: Formicidae)	+
(12) amuh	social wasp	(Family: Various)	+
(13) mehn	bee	(Family: Apidae)	+
Collective Forms:			
(14) ngoire	minute insects	(Various)	–
Aberrant Forms:			
(15) karere	earwig	Order (Dermaptera)	1:1
Transitional Forms:			
(16) kapoti	giant roach, mantid	Order (Dictypotera)	+
(17) kungont	solitary bee and wasp	(Various)	
(18) mehnkamamuh	honey wasp	(Genus: Brachygastera)	+

[1]BOL (Basic Object Level) Categories

[2]Correlations state in relation to correspondences at the scientific level of *Order* (+ indicates an over-differentiation; – is under-differentiation).

SUBORDINATE TAXONOMIC GROUPINGS

Groupings subordinate to BOL categories are subject to distinctive processes of characterization. Through what Hunn (1976: 512-512) calls "attribute reduction," certain of the nebulously encoded criteria of Basic Object Level categories are selected out as distinctive features for sub-groupings. These criteria often predict co-occurring sets of (for example, presence of hard wing covers always co-occurs with the presence of wings; the presence of scaly wings always co-occurs with the presence of fuzzy-elongaged abdomen, etc.). This type of "feature redundancy" is referred to as "configurational recoding" (cf. Hunn 1976:513; Bruner et al 1956:47). These criteria can be expressed in a limited number of componential features and are more easily expressed verbally by the Kayapó than are the BOL characteristics.

The degree to which a Basic Object Level category is subject to subgroupings indicates the following: (1) the importance of that particular set of organisms to the culture as a whole, or (2) the particular importance of that set of organisms to cultural "specialists."

Specialized knowledge is acquired in two ways: (1) from relatives as a part of one's ***nê kretx*** (inheritance), or (2) from another "specialist" through apprenticeship.

In a materialistic sense the Kayapó are egalitarian, but only in a materialistic sense. The "secrets" or rights one inherits as part of one's ***nê kretx*** do much to determine one's status. This specialized information usually deals with rights to perform certain songs, dances, or rituals. But one's ***nê kretx*** might also include specialized knowledge about curing or witchcraft.

There are many types of shamans for the Kayapó. Some are more powerful than others, depending partially upon the degree of specialized knowledge.

Shamans are able to "talk to" certain animal spirits ***(karon).*** Some animal spirits are considered to be more powerful than others. The more powerful the shaman, the more powerful the animal spirit to which he can speak. It is through "talking to" animal spirits ***(mry karon kaban)*** that a shaman can cause or cure illnesses, predict the future, or talk to the spirits of ancestors. Only the most powerful shamans can talk to all animals.[3] This means that knowledge about animals is specialized and as a result, the subordinate classification system of animals is specialized.

Two major problems are evident in eliciting subordinate insect classification systems: (1) to understand the totality of the subordinate groupings would require investigating the knowledge of each shaman, and (2) much of this specialized knowledge is highly secretive in nature.

A third factor must also be considered. There is a large group of men and women who also are "curers" ***(mê-kute-mekane-mari).*** These people specialize in the treatment of a number of native diseases. Their cures are effected through concoctions of plants and animal parts; no manipulation of animal spirits is utilized. There are dozens of these in any village. My partial inventory of such curers in Gorotire alone yielded a list of 154 individual specialists, which was over 25 percent of the population. Thus, the elaboration of subordinate classification that follows reflects my very limited knowledge of the total Kayapó system of specialized insect classification.

The categories that do show exceptional internal differentiation, either by specialists or the culture as a whole, inevitably represent categories of great cultural significance to the Kayapó. Category specialization (internal differentiations) has been shown to be a useful methodological tool and provides an *emic* guide to significant cultural phenomena (Posey 1981, 1983d).

Following are the BOL Categories with a brief outline of the subordinate taxonomic groupings that characterize each category.

Màrà*:** **Beetles and Kin.** The Kayapó use the term "relative" ***(ombikwa) with variable degrees of inclusiveness. All ***ombikwa*** are in some degree of relatedness one to the other. Thus ***mãrã (n) ombikwa***, relatives of beetles, are grouped together because of general features of relatedness. Each grouping of ***ombikwa*** is thought to have a "father" ***(bam)***. The father is generally distinguishable as the largest specimen of the group; for most BOL categories no particular organism is consistently labeled as ***bam***. For the category ***mãrã***, however, the rhinoceros beetle *(Stataegus* sp.) is specifically thought of as the father of all ***mãrã*** and, indeed, of all things with shells and no flesh. The rhinoceros beetle is one of the bulkiest insects found in the tropics and sometimes reaches over 15 cm in length; its distinctive large "horns" make it one of the most morphologically distinctive insects. The Kayapó call this beetle the ***krã-kam-djware***, the beetle with teeth on its head.

The ***krã-kam-djware*** cannot be considered a separate class of ***mãrã***, but rather is a distinctive representative of the subclass ***mingugu***. All Scarabaeidae collected in Gorotire was classified as ***mingugu***.

The ***mingugu*** (also called ***mãrãti***, or "big mãrã") are subdivided further into two groupings: (1) ***mingugu***, and (2) ***mingugu-ti***. The "***-ti***" affix denotes "largeness;" thus, the ***mingugu-ti*** are the large scarabs (of which the ***krã-kam-djware*** is the most notable example). The ***mingugu*** are the smaller scarabs and are sometimes said to be "children" of the larger ***mingugu-ti***.

The category ***mãrã*** has ten major subdivisions that follow to some extent the subdivisions of the scientific Order Coleoptera (Fig. 2).

(1) ***mingugu*** are characterized as having shiny, tough black shells and well-defined wings underneath. The shape of the scarab is distinctive and inevitably the key non-verbalized basis for this subgrouping. When consultants are asked how the ***mingugu*** differ from other beetles, they emphasized that ***mingugu*** are found around dung. The collection of ***mingugu*** made in Gorotire yielded only specimens of the superfamily Scarabaeoide (families including Passalidae, Lucanidae, Scarabaeidae). Some small scarabs collected were co-classified with the folk taxon ***ipoi***.

(2) ***ngoi-kam-mãrã*** are beetles characterized as living on, in, or under the water. The name of this group means "water beetles" and includes the scientific families Dytiscidae and Gyrinidae. The fact that these beetles can swim, as well as walk and fly seems to pose no problems of anomaly for the Kayapó, who are nonetheless fascinated by such abilities.

(3) ***pyka-kam-mãrã*** are ground dwelling beetles as the name implies ("***mara*** of the earth"). Beetles in this category are believed to be carnivorous because they are frequently found near carrion. Specimens from the following scientific families were collected as part of this folk taxon: Rhysodidae, Carabidae, Tenebrionidae, Cleridae, Cucujoidae, Cerambycidae, and Chrysomelidae.

(4) ***ngrot*** are beetles classified as being somewhat elongated and having shiny shells. The ***ngrot*** are said to live in tree bark and include all the Buprestidae or wood borers.

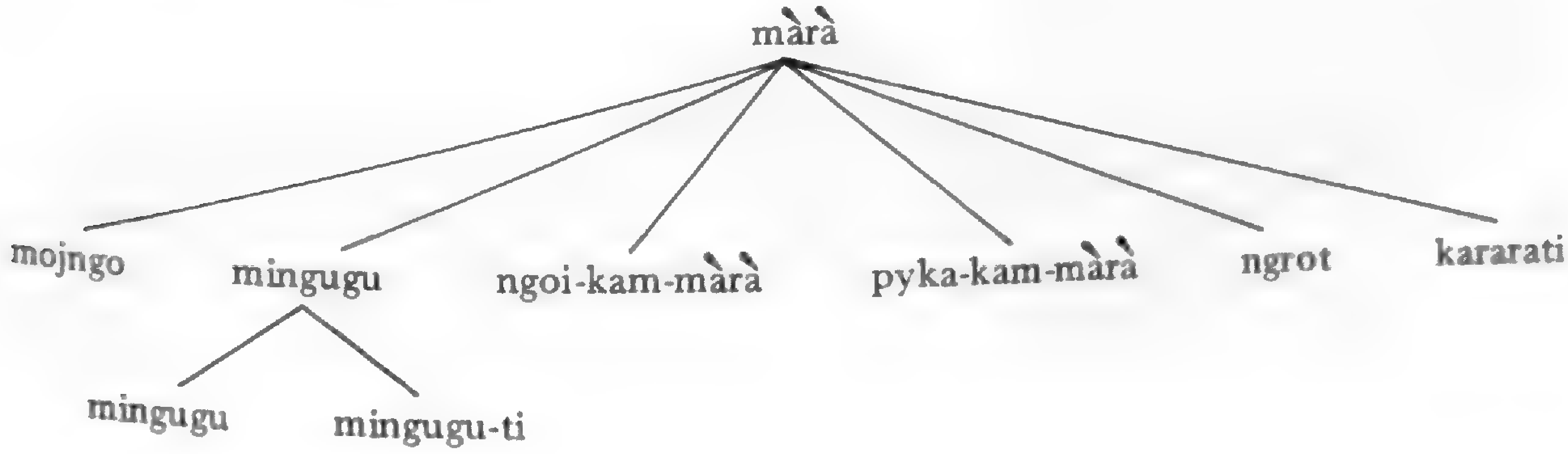


FIG. 2–Subdivisions of ***mãrã***.

(5) ***mojngo*** are weevils. These beetles are said to live on trees and shrubs. Their elongated snout serves as the diagnostic feature for this folk subclass, which coincides with the scientific families Curculionidae and Brenthidae.

(6) ***kàràràti*** are elongated beetles that coincide with the scientific families Elateridae and Lampyridae (click beetles and fire flies). The name means light-colored, translucent, glowing, or shiny-winged beetles.

(7) ***kikre-kam-màrà*** is an "undifferentiated utilitarian category" of beetles that live in the house and attack stored products. Most of these beetles are Dermestidae, but various other household insects are also lumped into this category.

(8) ***màrà-re*** is yet another undifferentiated category that includes a wide variety of beetles, including representatives of families Bostrychidae, Lyctidae, and Dermestidae.

(9) ***kapran-karon*** are the small, rounded and colorful insects we call "lady beetles." The name literally means "turtle image" beetles; this group consists mostly of small coccinellids (Coccinellidae). These are principal crop pests and are sorted by female informants into a variety of covert sub-classes based upon their preferred plant hosts.

(10) ***màrà-puni*** are the hairy rove and carrion beetles. The name means "ugly" or "repulsive" beetles, referring to their attraction to dead and decaying animals. These beetles are sometimes co-classified with ***ipoi*** (Hemiptera) because of their poorly developed wings and elongated bodies. The scientific families of Silphidae and Staphylinidae are represented in this category.

Continuous category set overlap occurs mostly with the blister beetles (Meloidae and Mordellidae), which are co-classified with ***ipoi*** (mostly Hemiptera). The reason for this appears to be the soft-wing covers ***(kà***, or elytra) that more closely resemble wings of ***ipoi*** than the hard "shells" of true beetles.

Except for the ***krã-kam-djware*** (rhinoceros beetle), there is little evidence of any particular use for beetles, nor any special symbolic or ceremonial significance. The palm weevil *(Rhynchophorus ferrugineus)* is given a special name, ***riño-krê-kam-màrà***. The larvae of this large beetle is said to have been an important food of the ancient Kayapó and is still eaten by some children and old people. These larvae reach a considerable size (three or four ounces) and have excellent food value. A large green metallic wood borer (Buprestidae) is also given a special name, ***màrà-ñibumpre***. The elytra of this beetle is commonly used in the tropical lowlands for decorative purposes.

A series of descriptive affixes is used in conjunction with the name ***mara*** to describe a certain specimen. These refer to color, shape, size, or texture and are used only as loose descriptive labels. Examples of name combinations are found in Table 2.

TABLE 2.—A list of affixes used in the description of various ***màrà*** specimens.

Affix	Translation	Affix	Translation
"-re"	diminuitive	"kakrãtyk"	jet black
"-kryre"	tiny	"kamrek"	red
"prĩre"	small	"ngrãngrã"	bluish
"tire"	large	"tyk"	black
"kra"	child (small)	"jaka"	white/gray
"kàprĩre"	short shell	"jadjen"	shiny

Common examples:	màrà-tyk-ti	(large, black beetle)
	màrà-pri-tire	(medium size beetle)
	màrà-kamrek-ti	(big, red beetle)

Ipoi: **True Bugs and Kin.** ***Ipoi*** are seen as having shells ***(kà)*** or wing covers that are not so tough ***(tytx)*** as most of the beetles ***(màrà)***. The ***ipoi*** are thought to live and feed on leaves of plants. The most typical of the ***ipoi*** are stink bugs (Pentatomidae) that are said to cause one's eyes to burn ***(me nô kang rô)*** and are called ***ipoi kumrenx***, the "true" *ipoi*.

There are four subgroupings of ***ipoi*** (Fig. 3).

(1) ***ipoi (kumrenx)*** are "true" ***ipoi***. The Kayapó have little to do with these insects because of the fear of being blinded by them. Shamans utilize ***ipoi kumrenx*** in various concoctions to induce or cure blindness and burning eyes. Informants easily recognized and grouped Pentatomidae specimens into this grouping on the basis of gross morphology, insisting that all insects in this group could cause harm to the eyes.

(2) ***ipoi (ka 'àk)*** are "false" ***ipoi***. These do not cause the eyes to burn, but are said to inflict painful bites. The ridged thorax of these ***ipoi*** is the generalized morphological feature that characterizes the group. These are the Reduviidae or assassin bugs.

(3) ***ipoi-tikà*** are the giant water bugs (Belostomatidae). Indians believe the ***ipoi-tikà*** can cause paralysis of anyone bitten by it. It is feared and avoided, except by shamans who utilize it in their crafts.

(4) ***ipoi-re*** is an undifferentiated category that includes other Hemiptera as well as a few Coleoptera (families Meloidae and Mordellidae).

The following descriptive affixes were elicited for ***ipoi:*** "***-jaka***" (white), "***-ngrãngrã***" (light color), "***-tyk***" (black, "***-kamrek***" (red), "***-kryre***" (small), "***-ti***" (large). Only the giant water beetle ***(ipoi-tikà)*** is given any specific polylexemic distinction.

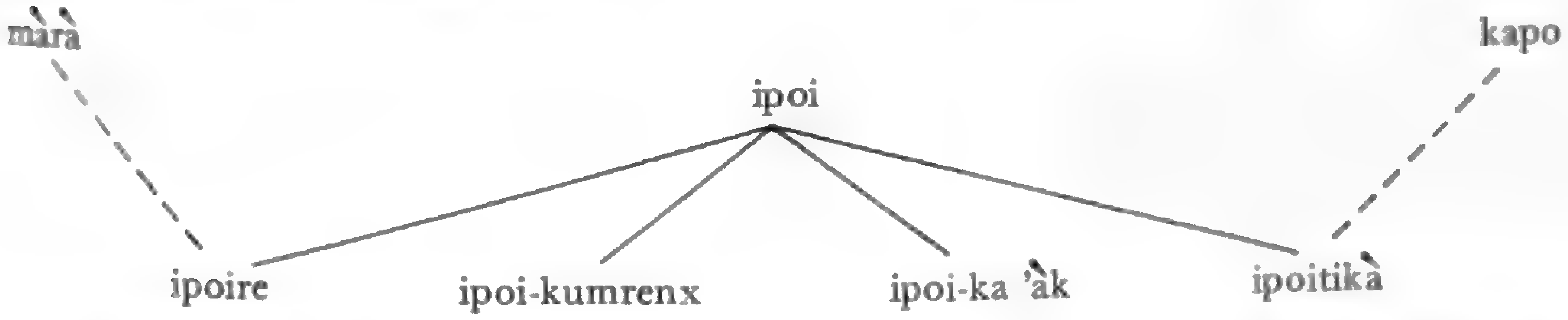


FIG. 3–Subdivisions of ***ipoi*** showing some subclass overlap between ***màrà*** and ***ipoi***, ***ipoi*** and ***kapo*** (indicated by dotted lines).

Kapo: **Cockroaches and Kin.** Cockroaches, mantids, walking sticks, crickets, and grasshoppers are generally grouped into the scientific Order Orthoptera, though some authors prefer to place cockroaches and mantids into a separate Order Dictoyptera. Regardless of which system is preferred, entomologists agree that these insect groups are closely related. The Kayapó likewise view these insects as closely related, and utilize three BOL groupings to distribute them: (1) ***kapo***, (2) ***kapoti***, and (3) ***krytkañet*** (mantids, grasshoppers, and crickets).

Kapo and ***kapoti*** should perhaps be viewed as two subgroupings of ***kapo***; that is, as ***kapo (kumrenx)*** and ***kapoti*** as in Figure 4-A. Informants consistently group ***kapoti*** at a level of contrast with ***kapo*** and ***krytkañet***; therefore ***kapoti*** is probably best treated as a separate Basic Object Level category rather than a subclass of ***kapo*** (as in Figure 4-B). The

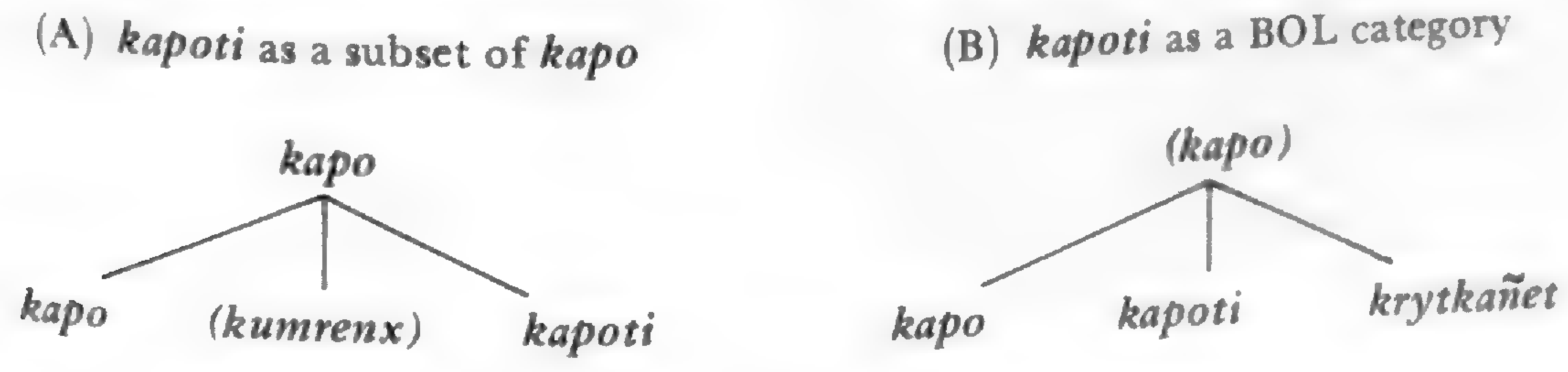


FIG. 4.–Two possible models of set relationships between ***kapo***, ***kapoti***, and ***krytkañet***.

grouping ***kapo*** includes all insects of the suborder Blattaria, except for the extremely large winged forms of family Blattidae.

The ***karêre***, earwig (Dermaptera), is seen as a special type (aberrant form) of *kapo*. It is shaped like a ***kapo***, but does not have the same type of wings or abdomen. The ***karere*** are associated with dark, damp places and are believed to be an omen of illness or death. ***Karêre*** are associated with spirits of the dead and whenever too many *karêre* are seen in a house, it is assumed to be a sign of spirits in the house. The Kayapó traditionally abandon and burn a house after several deaths have occurred because of fear of spirits returning to their old homes.

Kapoti:* A Transitional Form**. Little can be said about the ***kapoti, except that they are some of the largest insects encountered in the Kayapó area. Large cockroaches of the scientific suborder Blattodea are grouped with pyranus beetles (Prioninae) in this category. The bodies of the ***kapoti*** are like those of the ***kapo***, except that their impressively large wings cause them to be considered as relatives of ***krytkañet*** (grasshoppers).

Kapoti are ground into a powder and used by various shamans to cause or cure illness and blindness. Specimens of this group are hoarded by shamans to prepare various concoctions.

Krytkañet:* Grasshoppers and Kin**. Grasshoppers are one of the most numerous forms of life in the Kayapo area, especially in the grasslands and transitional forest. Eight major subdivisions can be described within the category ***krytkañet (Table 3).

(1) *moi 'ô' ja 'àrà* are the katydids or long-horned grasshoppers (Tettigonioidea). An extremely large species occurs in the area and is given the special name *krytkañet-kàràràti*. Its legs are used to treat aching or weak joints. The spiny part of the back legs are removed and scratched over the afflicted joints, sometimes until blood is drawn. Contact with the strong legs of the *moi 'ô' ja 'àrà* is believed to impart its strength to the user. The name means "leaf-like" ***krytkañet***, referring to its protective coloration and leaf imitative wing veination.

(2) ***chỳrê-chỳrê*** are the large grasshoppers of the family Acrididae. During the dry season these huge insects appear in great abundance. It is said that in the ancient days the Kayapo ate these as delicacies, but there is no evidence that they are still eaten today. The legs of the ***chỳrê-chỳrê*** are utilized for curing in the same manner as the

TABLE 3.—Subgroupings of ***krytkañet*** with analagous scientific classifications.

	Krytkañet (Orthopteriods)	
Subgroupings	Common Names	Scientific Taxons
(1) moi 'ô' ja 'àrà	Katydid	Tettigonioidea
(2) chỳrê-chỳrê	Grasshopper	Acridoidea
(3) Pàt-karoñ	Mantis	Mantodea
(4) wêjaputchô	Walking stick	Phasmatoptera (or Cheleutoptera)
(5) ngra-rêrêmex	Mole cricket	Gryllotalpoidea
(6) krytkañêre	Cricket	Grylloidae
(7) krytkañet-ka 'àk	Grouse locust	Tetrigoidea
(8) krytkañet (kumrenx)	"Locust"	Acridoidea

legs of the *moi ô' ja 'àrà*. The large rib vein of the upper wing is also removed from the rest of the wing and used in shamanistic ceremonies that are intended to cause or cure paralysis of victims. The name of this category is derived from the flight sound made by a focal member of the category.

(3) ***pàt-karõn*** are the mantids (Mantodea), some of which reach six inches or more in length. The name means "anteater image" and refers to the similarity perceived between the front legs of the mantis and those of the giant anteater. Indians say the mantis holds it prey in the same manner as the ***pàt*** (anteater).

(4) ***wêjaputchô*** are the walking sticks (Phasmatoptera or Cheleutoptera). The Kayapó say contact with these can cause blindness and shamans use the ground-up parts of certain species to inflict blindness. In many ways the walking stick is aberrant morphologically, particularly because of its wings. The body, head, and legs, say the Kayapó, are those of ***krytkañet***. I do not know the meaning of the name for this class.

(5) ***ngra-rêrêmex*** are the mole crickets (Gryllotalpoidea). Their name means "pretty paca" and refers to their similarity in shape and coloration to the rodent "paca." Because these crickets are heard and seen at night, they are associated with death and ghosts and are harbingers of disaster.

(6) ***krytkañére*** are the true crickets (Grylloidea). These are distinguished by the Kayapo because of their songs and their distinctive wings. Crickets are common in Indian fields and are associated with good crops and abundant rains. They are favored fish bait for Indian boys, who spend hours chasing them for that purpose.

(7) ***krytkañet-ka 'àk*** are the grouse locusts (Tettrigoidea). The morphological form of these is distinctive and easily recognized by the Kayapó as being "false" ***krytkañet***.

(8) ***krytkañet-kumrenx*** are the true locusts (Acridoidea). There are five unnamed (covert) subdivisions of this group.

a. those found in the grasslands ***(kapot)***
b. those found in the transitional forest ***(bà-ràràrà)***
c. those found in the high forest ***(bà-tyk)***
d. those found near rivers ***(ngô-kôt)***
e. those found in or on the ground ***(pyka-kam)***

No generic or specific scientific determinations were made for these subgroupings. It is interesting to note, however, that the Indian recognize certain forms (morphological types) as more "typical" of the various ecological zones. There are five ecological zones recognized by the Kayapó that correspond to the five groupings of ***krytkañet-kymrenx*** listed above. Informants made minimal grouping "error" in sorting ***krytkañet-kumrenx*** despite the specimens being "out of ecological context."

The noted acridologist Uvarov (1977:371-444) has attempted to group grasshoppers and crickets into "life forms" based on generalized morphological adaptations to particular ecosystems or "life zones." Five basic "life zones" recognized by Uvarov are: (1) "terricoles," those living on the ground and feeding on herbs; (2) "aquacoles," those living in or on the water; (3) "arboricoles," those living on trees and woody shrubs; (4) "herbicoles," those living in dense thickets of shrubs and herbs; and (5) "grammicoles," those living in grasslands. This attempt to account for phylogenetic relationships between morphological adaptation and the functional success of a species associated with ecological zones appears to coincide with the Kayapó system.

The term "life form" as used by Uvarov is confusing for ethnobiologists because of the current use of the same term as a general folk taxonomic unit. Perhaps "ecoform" would be a less ambiguous word that could be adopted by ethnobiology. Whatever the term, I believe ethnobiologists need to follow lines of investigation that analyze native perceptions of adaptive associations between species morphology and ecosystem.

Wewe: **Butterflies and Kin.** The Basic Object Level category *wewe* could be considered as a collective form. Six orders of insects are subsumed under this one label: Neuroptera, Ephemeroptera, Plecoptera, Mecoptera, Trichoptera, and Lepidoptera. The focus of the entire category is the giant morpho butterfly *(Morphinae)*.

Seven folk subgroupings occur within the basic category so that in the overall scheme the underspecialized category ***wewe*** becomes a focal category differentiated by the degree of morphological feature recognition. The subdivisions are as follows:

(1) ***wewe (kumrenx)*** are butterflies and moths (Lepidoptera). Wing scales are the distinguishing characteristic, and scales are used by shamans to treat diseases of lethargy. A covert differentiation within this category is found between night-flying and day-flying species. Moths and other night-fliers are considered omens of death or illness.

(2) ***wewe-jaka*** are the mayflies (Ephemeroptera). The suffix "***-jaka***" ("whitish") is often used loosely as a descriptive affix. In this case, however, ***wewe-jaka*** labels a specific subclass of ***wewe***. Although these appear at night, the Kayapô do not find them disturbing; on the contrary, they are always a sign of abundant fish and good fishing.

(3) ***wewe-ja 'àrà*** are the stoneflies (Plecoptera). The suffix "***-ja 'àrà***" denotes a translucent quality of the wing. This subclass defines the particular set of Plecoptera.

(4) ***wewe-ka 'àk*** are the "false" ***wewe***. This category coincides with the scientific Order Mecoptera, scorpionflies.

(5) ***ngôi-kam-wewe*** are the caddisflies (Trichoptera). The name refers to the affinity of this set of organisms for the water and areas surrounding lakes and rivers.

(6) ***pingôkrã*** are the fish flies and dobson flies (Corydalidae). The name literally means "worm head" and refers to the sometimes elongated thorax and head of the family.

(7) ***pi 'ô' ja 'àrà*** are the lacewings and kin (all Neuroptera, except Corydalidae). The name literally means "leaf wings" and is descriptive of the delicate, transparent veined wings for which the Order is named.

Though generally oblivious to insect life cycles, the Kayapô are aware of the stages of metamorphosis of Lepidoptera. The eggs they call "***ngrê***," the larvae "***pingô***," the cocoon or chrysalis "***krakà***" ("child cover").

The stinging larvae of various unidentified Lepidoptera are incorporated into the rituals prescribed for warriors and are smashed on the bare chests of the young men. The intense pain is believed to impart strength and remove fear. Often the ordeal leaves scars on the chest that are sported proudly as though they were battle scars.

Kokot: **Cicadas and Kin**. There are only two basic subdivision of ***kokot***. The focus of the entire category is the large annual cicada (Cicadidae). The two subgroupings follow:

(1) ***kokot (kumrenx)*** are the "true" ***kokot***. This category coincides perfectly with the scientific Family Cicadidae. The principal vein of the cicada's front wing is used by shamans in sorcery.

(2) ***kokot-kryre*** are the "tiny" ***kokot***. This category includes the treehoppers (Membracidae), froghoppers (Cercopidae), leafhoppers (Cicadellidae), and the plant hoppers (Fulgoridae). I know of no special use or significance of this subgroup.

The usual variety of non-fixed descriptive suffixes are evident; for example: ***-krôre*** (painted), ***-prîre*** (small), ***-tire*** (large, ***-kamrek*** (red), ***ngrãngrã*** (light colored), ***-tyk*** (black), and so on.

Ngôire, Pure and ***Kopre:*** **Flies and Kin**. The third sequence has three closely-related Basic Object Level Categories: ***ngoire, pure***, and ***kopre***. The category ***ngôire*** is a collective one containing a myriad of small insects too small to be distinguished morphologically by the unaided eye. I did not make a collection of the insects in this category so I can only guess at the vastness of its inclusiveness.

The category ***kopre*** is likewise a very nebulous category. Within this group are all flies (Diptera), except those contained in the category ***pure***. All forms are known to have only two wings. There are no further subgroupings.

The category ***pure*** is subdivided into three groups, all of which are blood-sucking and biting species:

(1) ***pure (kumrenx)*** are small blood-sucking flies. This includes the punkies (Ceratopogonidae), midges (Chironomidae), and black flies (Simuliidae). The Kayapó distinguish four types of ***pure kumrenx:*** *(a)* ***putykre*** (black ones, (b) ***putire*** (big ones), (c) ***pukrã̄krôti*** (spotted-headed ones), and (d) ***pukrã̄kamrek*** (red-headed ones). Distinctions among the four are not only morphological, but also biological, i.e., where they are found and the viciousness of the bites.

(2) ***pute*** are the mosquitoes (Culicidae). There are four sub-divisions of ***pute:*** (a) ***pute-jaka*** (whitish ones with very painful bites), (b) ***putepryjaka*** (greyish ones found in the forest along trails), (c) ***putekamrek*** (reddish ones found in open areas), and (d) ***putetykre*** (black ones found in the forest).

(3) ***pumnuti*** are the deer and horseflies (Tabanidae). There are no further subdivisions of this category.

The overall relationship between ***kopre*** and ***pure*** is represented by line diagrams in Fig. 5.

The ***pumnuti*** (Tabanidae) are seen as being morphologically more similar to ***kopre*** than ***pure.*** Their fierce biting habits, however, cause Indians to place them in the category with other blood-sucking and biting species. There are more detailed subclassifications of mosquitoes and pium, but collections and analyses are yet to be made.

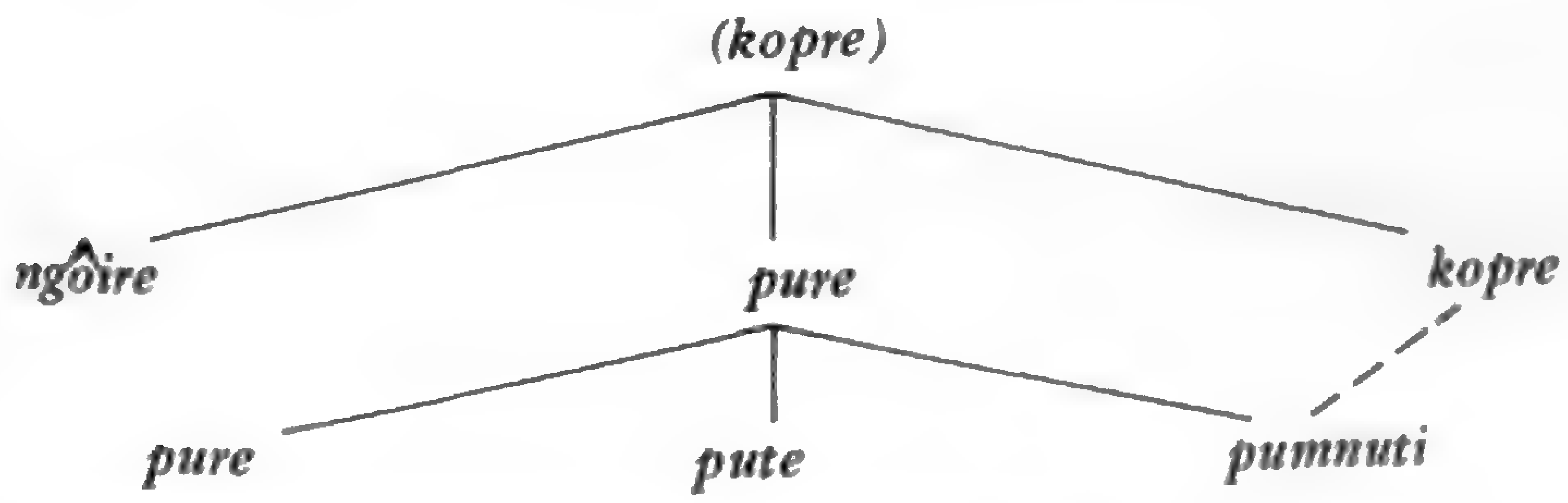


FIG. 5.–Category relationships within flies and kin *(kopre)*

Rorot: **Termites and Kin.** Termites (Isoptera) are abundant in the Kayapó area, although the Kayapó pay relatively little attention to them. Four major subdivision or ***rorot*** are found.

(1) ***rorot-tykre*** are termites that build nests in trees. These are the "black" termites and are associated with the origins of black people on the earth.

(2) ***rorot-krã̄-kamrek-ti*** are termites that nest in the wood of houses. These "red-headed" termites are associated with the origins of other Indians (non-Kayapó) in the world.

(3) ***rorot-jakare*** are termites that nest in the ground. These are the "white" termites that are associated with the origins of Europeans in the world.

(4) ***rorotire*** are termites that build large, greyish mounds. Termite mounds are numerous, especially on the campos, and all non-Kayapó ***(kuben kakrit)*** emerged from the underworld to the earth through these mounds.

Whereas the Kayapó have a fascination and even admiration for other social insects, the termites are thought of as useless and helpless. They are weak and non-aggressive and therefore no more "true" ***ñy*** (social insects) than ***kubẽn kakrit*** (non-Indians) are "true" people. True people (the Kayapó) originated above in the sky; not from below in the ground as did non-Indians.

Termite nests are used in house construction, since their comb construction serves as an ideal natural insulation. Nests of *Nasutitermes* are also used as fertilizers, or mixed with organic mulch to create fertile planting zones in savanna areas. On numerous occasions I observed the Kayapó eating the textured nest of ground-dwelling termites and ants. No explanation was offered other than in the ancient days the Kayapó say they ate this in place of farinha (toasted manioc flour). Geophagy is not commonly reported in indigenous cultures, but was certainly common with the Kayapó and is evident today to some extent.

Mrum: **Ants and Kin.** Ants (Formicidae) are a source of great interest to the Kayapó (Posey 1981). Their social nature is thought to be similar to that of the Kayapó and, consequently, their ethology is important in classification. The major basis for subgroupings of ants is the type and location of their nests ***(ũrũkwa)***. The following covert (unnamed) groupings were found:

(1) ants with nests in the ground
(2) ants with nests above ground (mound building)
(3) ants with nests inside tree trunks
(4) ants with nests outside tree trunks (have visible nests attached to the tree trunk)
(5) ants with nests inside tree limbs
(6) ants with nests attached to tree limbs or leaves
(7) ants that live with termites
(8) ants that live with bees
(9) ants that live alone (solitary forms).

The last grouping of solitary ants is often co-classified with wasps ***(amub)***. These are called "velvet ants" (Mutillidae), which are in fact wasps of the superfamily Scoliodidae. A large ant with conspicuous winged males is likewise co-classified with ***rorot*** (Isoptera). These two examples represent the set overlap between contiguous categories ***(rorot, mrum***, and ***amub)***.

Ants are often spoken of in terms of their "power," or ability to inflict pain. The more potent the sting, the more powerful the ant. Some shamans specialize in "talking to" powerful ant species and claim to manipulate their spirits to cause harm. The shamans have a special classification of ants based on the power of ant spirits ***(karon)***. To date 64 different ant folk species have been collected and described.

The abdomen of the "saúva" ***(mrum-tuti***; *Atta sexdens* L.) is the only ant eaten. Its fat and juicy abdomen is mixed with manioc flour and baked, or whole ants may be roasted in banana leaves.

Stinging ants are often collected by the Kayapó men. Ant bodies are pounded into a paste with red urucu *(Bixa orellana)* and painted on hunting dogs. This is supposed to cause the dogs to keep their noses to the ground and to hunt with determination as the ants do.

Azteca sp. ants are thought to have a smell that repels sauva *(Atta sexdens* L.) and their nests are actively distributed near fields and gardens to produce a protective barrier against sauva. Their nests are also planted with yams and taro to increase tuber yields.

Amub: **Wasps and Kin.** Non-honey-producing wasps and stinging bees are grouped into the category ***amub***. Subgroupings of ***amub*** seem to be based on the type of nest ***(ũrũkwa)***. Variation in identification of wasps "out of environmental context" was found to be very high. Consultants were later brought to the Museu Goeldi to identify 120 wasp nests. Identification of wasp *nests* "out of context," however, was found to be extremely consistent with identifications and observations made in the field. This seems to indicate that the Kayapó pay more attention to wasp nest construction than to the morphology of the wasps themselves.

The principal dichotomy within the Basic Object Level category ***amub*** is between (1) social species, and (2) solitary species (those that do not live in ***ũrũkwa***). Subgroupings of each of these are outlined in Table 4.

TABLE 4.—Subgroupings of *amub*.

Subgrouping	Common Names	Scientific Correlate
(1) Solitary ***amub***		
(a) ***ambu-poi-ti***	"ichneuman fly"	Ichneumonidae
(b) ***prytumre***	"spider wasp"	Pompilidae
(c) ***mỳt-te***	"sand wasp"	Sphecidae: Larrinae
(d) ***'apiêt-ti***	"mud daubers"	Sphecidae: Nyssoninae
(e) ***ajabamñy***	"thread-waisted wasps"	Sphecidae: Sphecinae
(f) ***pyka-õ-ñy***	"potter wasps"	Vespidae: Eumeninae
(g) ***amubre***	an undifferentiated category of various families, including, Symphyta	
(h)[1] ***rop-krôre-karõn***	"velvet ant"	Scoliidae, Mutillidae
(i)[2] ***kungõnt***	"solitary bees"	Xylocapinae
(2) Social ***amub***		
(a) ***mingugu***	"social bees"	Apidae: Apinae
(b) ***mebnkamamub***	"honey wasps"	Brachygastra sp.
(c) ***amub (kumrenx)***	"social wasps"	Vespidae

[1]***rop-krôre-karon*** is co-grouped with ***mrum***

[2]***kungõnt*** is a transitional class between ***mebn*** and ***amub***; ***mebnkamamub*** is a transitional class between honey-producing bees and wasps.

Most social wasps are used in some form of hunting magic. Most commonly, wasp parts are mixed with urucu *(Bixa orellana)* and painted on the warrior. Certain wasp nests are even used to rub over the noses of hunting dogs to make them brave *(akrê)*. To date 85 folk species of wasps have been identified and described.

***Mebn*: Honey-Producing Bees and Kin.** Thus far 56 folk species of stingless bees (Meliponinae) have been discovered for the Kayapó corresponding to 66 scientific species (Posey 1983a). Of this number, 11 species are considered to be semi-domesticated (Posey 1983b).

Bees are grouped into 15 "families" in addition to the 56 folk species. Criteria for determining these differentiations are complex and include the following:

1. Ethological characteristics: (a) flight patterns (how the bees fly when entering the nest), (b) aggressive behavior when the nest is disturbed (aggressive or docile); (c) sound produced by bees in flight or by nocturnal behavior inside nest; (d) places bees visit, including types of flowers, dead animals, feces, sand banks, dirt, etc.

2. Nest structure and ecological niche: (a) substrate preferred (eg., tree hollows, ant nests, termite mounds, inside earth, large trees, etc. In the case of trees, external nest form and position of the entrance structure is also important); (b) ecological zone preferred (flood forest, humid forest, savanna, etc.); (c) form, texture, color and smell of

the entrance structure (eg., earth, resin, cerumen, vegetable fibers, etc.); and (e) form and texture of the batumen.

3. Morphological and biochemical characters: (a) shape of the bee's body; (b) colors of the bee; (c) designs or markings on body; (d) size and color of wings; (e) size of the bee; (f) smell of the bee (either its natural smell or when the bee is crushed); (g) secretions produced for defense.

4. Economic factors: (1) quality of honey; (b) quantity of honey; (c) quality of resins; (d) quality of wax and cerumen; (e) suitability of pollen for food; (f) suitability of larvae/pupae for food.

As this list of taxonomic characters indicates, the Kayapó also have a detailed knowledge of Meliponinae morphology, nest architecture, ontogeny, and behavior. Technologies and strategies for raiding nests and rearing bees are also well-developed (see Posey and Camargo 1984). The Kayapó use bee waxes, batumen, resin, pupae, and larvae for a variety of purposes (Posey 1983c).

SUPERORDINATE GROUPINGS

Of the 18 BOL categories found in the Kayapó system of Arthropod classification, only three show extensive differentiation at subordinate levels (***amub***, wasps, with 85 folk species; ***mrum***, ants, with 64 folk species; and ***mebn***, bees, with 56 folk species). Following the hypothesis that such differentiation is indicative of emically significant cultural phenomena (cf. Posey 1983d), one would predict bees, wasps, and ants to be of particular importance to the Kayapó.

An additional indicator of the importance of these BOL categories is the named superordinate grouping of all social Hymenoptera, ***nby (ñy)***, which includes all ***amub***, ***mrum*** and ***mebn***.[5] ***Nby (ñy)*** is the only named, superordinate category in the entire domain of ***mry-kati*** (animals with shells and no flesh).

This phenomenon is explained by the epistomological importance of social insects to the Kayapó belief system. The Indians say that their social organization was conceived by an ancient shaman who specialized in the study of social Hymenoptera. Hoping to organize his defenseless, dispersed people against attacks from the wild beasts and enemies, the shaman had the idea to organize the Kayapó like ***nby (ñy)***. This idea came while observing a hive of wasps ***(amub-djà-kein)*** successfully defending themselves against an eagle ***(bàk)*** hundreds of times larger.

This Kayapó belief indicates that the Indians have long been interested in social insects as a "natural model". There are still specialists who study ***nby (ñy)*** and the importance of social insects is manifested, symbolically in art, music and, most dramatically, ritual (cf. Posey 1983b). The named category ***nby (ñy)***, therefore, encodes epistomological significance in the Kayapó culture and is an indicator of symbolic cultural significance.

In addition to the named, superordinate category of ***nby (ñy)***, numerous loose, nebulous groupings can be found. These "cross-cut" (cf. Gardner 1976) BOL categories recognize a variety of other characteristics held in common with other animals (Fig. 6).

Any given organism might be grouped with other organisms in numerous ways. A frog might be grouped with a water beetle because both are amphibious. A turtle, an armadillo, and a lady bettle might be grouped together because all three have round humped shells. A caterpillar might be grouped with a snake because it is long and wriggles on the ground. Stinging caterpillars might also be grouped with wasps and ants because of the nature of their stings. A flying ant might be classified with a certain hawk because both appear at the same time of the year (the hawk is migratory; the emergence of the winged ant seasonal). A type of cricket might be classified with a tapir because its front feet are seen as similar in form.

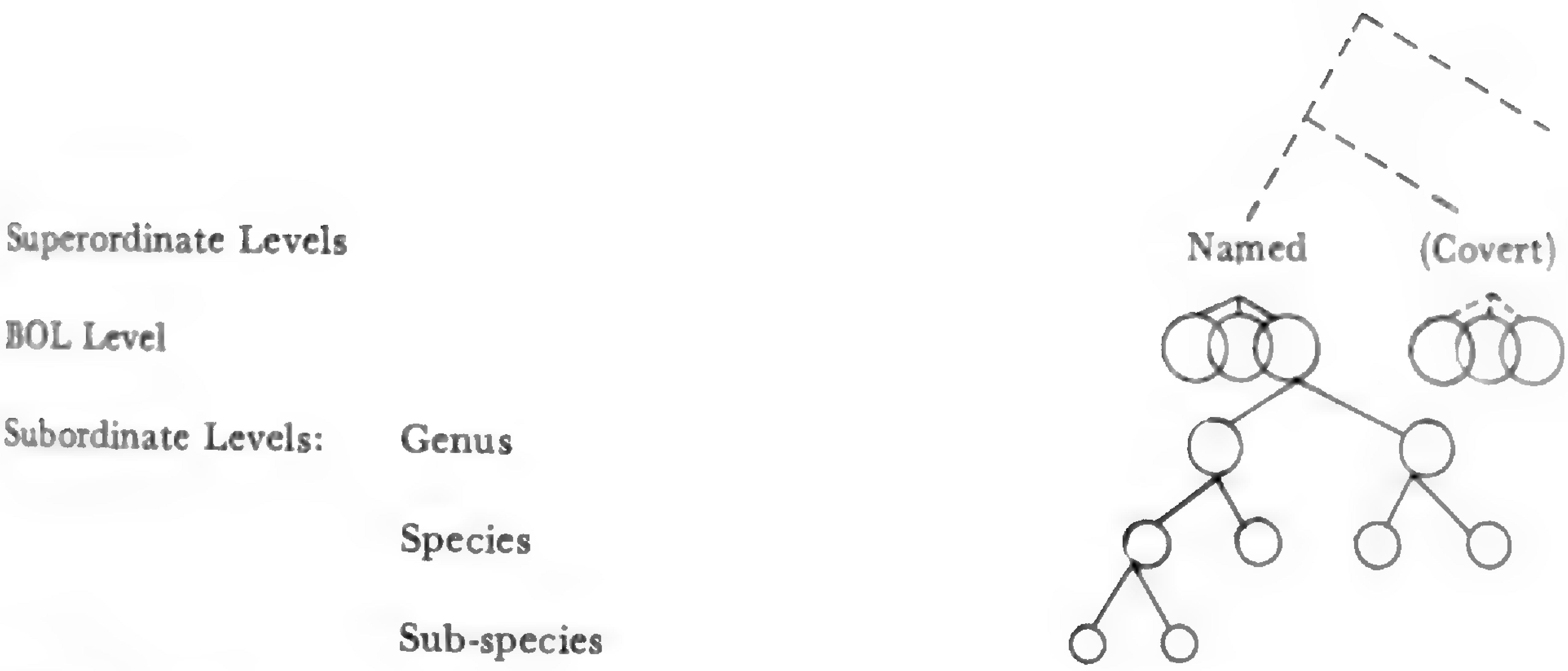


FIG. 6.–Idealized hierarchical model showing superordinate and subordinate levels.

The list can go on and on. In observations of superordinate groupings, I have observed four types of "cross-cutting" mechanisms. Animals are grouped on the basis of:

1. similar function (eg., edibility, medicinal value, ceremonial importance, etc.)
2. behavioral characteristics (e.g., nocturnal animals, crepuscular animals, swimmers, etc.)
3. habitat (eg., water animals, forest animals, ground-dwellers, etc.)
4. special cultural concerns. The latter type of grouping deserves some further explanation.

One of the major ways the Kayapó group animals is by the "power" of their "spirits" (*karõn*). This is an extremely difficult typology to analyze and describe, for the concepts of animal "power" and "spirit" are exceedingly complex. An animal's "power" is determined by the facility of the ***karõn*** in inflicting or curing illness. Every animal species has a "spirit" and, theoretically, every animal can affect the human "spirit" by causing or curing illness. Only the shamans who "talk to" the animal spirits can cure a patient of the disease provided by the spirit of that animal. Therefore, the ranking of animals based upon the "power" of their "spirits" is tantamount to ranking the power and prestige of shamans.

Superficially certain groupings seem nonsensical. For example, the Kayapó group certain lizards, some snakes, grubs, and small rodents into one category. This grouping appeared to defy reason until tribal elders were heard telling of the ancient days before the Kayapó had corn and manioc. The list of animals eaten in ancient times coincided with this grouping and is best glossed as "animals of potential use" and offers a "back-up" or emergency system that is encoded in the classification system and passed from generation to generation. Mythological principles of today can become facts of survival tomorrow.

CONCLUDING REMARKS

Classification of ***mry-kati*** (Arthropods) by the Gorotire Kayapó offers several interesting insights into the overall patterns of folk biological classification. The 18 BOL categories grouped in morphological sequences show very little hierarchical differentiation except for the social insects (***amub***, ***mrum***, and ***mebn***), which are the only representatives to receive a named, superordinate grouping ***nby*** (***ñy***).

Certain BOL categories, especially ***krytkañet*** (Orthopterans), seem to be distinguished based upon perceived phylogenetic relationships between animal morphological form and its ecological adaptation or niche. These "ecoforms" merit study and offer ethnobiologists additional intergrative paradigms for research.

Specialization of Kayapó knowledge points to the difficulty of an overall evaluation of any complete biological/natural taxonomic system. This problem is accentuated when trying to determine the "utilitarian" value of any given domain.

The Kayapó data suggest that elaboration or differentiation of named subordinate (lower in hierarchical rank than BOL categories) categories, whether in the general knowledge system or only known by a few "specialists," is an accurate indicator of "utility" and cultural significance. No attempt has been made to determine if degree of difference is in direct proportion to significance or utility, but such a hypothesis seems feasible and deserves testing. Highly differentiated categories recognized by the society as a whole should be the strongest indicator of cultural utility or significance.

"Utility" is difficult to assess since it does not always include the obvious qualities of food, shelter, or medicine. In the case of ***nhy (ñy)***, social insects, for example, only bees have the obvious utilitarian value of producing food, medicine and useful raw materials. Ants are utilitarian in the sense that they have qualities that are desirable to impart to hunting dogs via medicinal mixtures painted on the dogs. Wasps are important in a more abstract way as "natural models" for Kayapó society, although certainly avoidance of stinging species may be considered utilitarian and influence classification. Such avoidance, however, is not the sole reason for wasp classification since only a small percentage are aggressive.

The Kayapó data also suggest that categories of great symbolic or epistomological significance are not only differentiated and named at the subordinate level (usually only by "specialists"), but are also labeled in superordinate (groupings of greater set inclusion than BOL categories) groupings. One can hypothesize therefore that the named superordinate groupings are indicator of symbolically significant domains.

Kayapó classification of insects and related Arthropods is characterized by classification of "natural discontinuities" in nature that produce morphologically determined Basic Object Level (BOL) categories. Organization of BOL categories is seen as a continuum of overlapping or contiguous sets called "morphological sequences." Hierarchical structures emerge when any BOL category (or sequence) is of utilitarian and/or symbolic significance. Named subordinate differentiation is an indicator of "utility;" named superordinate groupings are indicators of symbolic significance.

Thus parts of the folk taxonomic system that exhibit greater hierarchical qualities reflect recognition of "utility" in its broadest sense (practical and symbolic). This resolves the apparent "contradiction" between utilitarian and hierarchical models by pointing out the difference between *process* (essentially hierarchical) and *purpose* (essentially utilitarian) in folk taxonomy. Both are at work in any folk classification system and neither excludes the other in importance nor explanatory potential.

LITERATURE CITED

BERLIN, BRENT. 1972. Speculations on the Growth of Ethnobotanical Nomenclature. J. Lang. and Soc. 1:63-98.

———. 1973. Folk Systematics in Relation to Biological Classification and Nomenclature. Annu. Rev. Ecol. Syst. 4:259-271.

———. 1976. The Concept of Rank in Ethnobiological Classification: Some Evidence from Aguaruna Folk Botany. Amer. Ethnol. 3:381-399.

BERLIN, BRENT, DENNIS E. BREEDLOVE and PETER H. RAVEN. 1966. Folk Taxonomies and Biological Classification. Secence 154:273-275.

———. 1973. General Principles of Classification and Nomenclature in Folk Biology. Amer. Anthrop. 75:214-242.

BROWN, CECIL H. 1977. Folk Botanical Life-Forms: Their Universality and Growth. Amer. Athrop. 79:317-342.

——— 1979. Folk Zoological Life-Forms: Their Universality and Growth. Amer. Anthrop. 81:791-817.

BRUNER, J. S., J. J. GOODNOW, and G. A. AUSTIN. 1956. A Study of Thinking. Wiley, New York.

GARDNER, PETER M. 1976. Birds, Words and a Requium for the Omniscient Informant. Amer. Ethnol. 3:446-468.

HAYES, TERENCE E. 1982. Utilitarian

LITERATURE CITED (continued)

Adaptationist Explanations of Folk Biological Classification: Some Cautionary Notes. J. Ethnobiol. 2(1):89-94.

HUNN, EUGENE. 1975. A Measure of the Degree of Correspondence of Folk Biological Classification. Amer. Ethnologist 2:309-327.

——— 1976. Toward a Perceptual Model of Folk Biological Classification. Amer. Ethnol. 3(3):508-524.

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

——— 1982. The Utilitarian Factor in Folk Biological Classification. Amer. Anthrop. 84(4):830-847.

KAY, PAUL. 1971. Taxonomy and Semantic Contrast. Language 47:866-887.

POSEY, DARRELL A. 1979. Ethnoentomology of the Gorotire Kayapo of Central Brazil. Unpubl. Ph.D. dissert. Anthr., Univ. Georgia, Athens.

———. 1981. Ethnoentomology of the Kayapo Indians of Central Brazil: Wasps, Warriors and Fearless Men. J. Ethnobiol. 1(1):165-174.

——— 1983a. Folk Apiculture of the Kayapo Indians of Brazil. Biotropica 15(2): 154-158.

———. 1983b. Keeping of Stingless Bees by the Kayapo Indians of Brazil. J. Ethnobiol. 3(1):63-73.

———. 1983c. The importance of Bees to an Indian Tribe of Amazonia. Florida Entomologist 65(4):452-458.

———. 1983d. O Conhecimento Kayapo: Etnometodologia e Sistema Cultural. Anuario Antropologico 81:109-124.

POSEY, DARRELL and JOAO M.F. de CAMARGO. 1984. Additional Notes on the Classification and Knowledge of Stingless Bees (Meliponinae, Apidae) by the Kayapó Indians of Gorotire, Para, Brazil. Annals of the Carnegie Museum, Pittsburgh, PA. In press.

ROSCH, ELEANOR. 1978. Principles of Categorization. *In:* Cognition and Categorization. E. Rosch and B. Lloyd, Eds. pp. 27-48. Erlbaun, Hillsdale, New Jersey.

UVAROV, BORIS. 1978. Grasshoppers and Locuts: A Handbook of General Acridology. Vol. 2. Centre for Overseas Pest Research, London.

NOTES

[1]Funding for this research came from the Wenner-Gren Foundation for Anthropological Research.

[2]*Mry kati* ("false flesh," or "no meat") is an animal type of *maja* ("unimportant things," or, in American slang, "stuff"). *Mry kati* could also be considered a type of *mry kaigo* ("empty meat"). In a previous publication (1983b), I employed the term *Maja* without its additional modifiers. My thanks to Cecil Brown, Terence Hayes, and Eugene Hunn for pointing out this fault.

[3]I was told that no shaman in any Kayapó village today had this power. The last shaman, a woman, had died in Gorotire in 1972. The most powerful shamans that exist today are those who speak to the water eel *(mry-kaàk)*.

[4]Termites *(rorot)* are also included in the superordinate category of *nhy (n͂y)*. The fact that they are not differentiated at the subordinate level as are other members of the group is explained in Posey, 1983b.

Book Reviews and Abstracts

In our last issue, Volume 4 Number 1, Gary Paul Nabhan did not receive full recognition for his review of *Medicinal Plants of the Bible* (p. 14). I apologize for this oversight. I have adopted the convention of using initials for reviews written by the *Journal* staff and spelling out the names and addresses of outside contributors.

Charles H. Miksicek
Book Review Editor

Book Review

Ethnobotany in the Neotropics. Edited by G. T. Prance and J. A. Kallunki. Bronx: The New York Botanical Garden, 1984. 156 pp. paper, index, illustrated, $29.75 U.S. Orders, $30.75 non-U.S. Orders.

Ethnobotany in the Neotropics contains the proceedings of a symposium, by the same name, presented at the 1983 Society for Economic Botany meetings. It is the inaugural issue in the *Advances in Economic Botany* series to be published by the Institute of Economic Botany at The New York Botanical Garden. Although the title suggests all of the New World tropics, the geographical focus of most of the papers in the volume is Amazonian South America.

This collection contains a mixture of both short topical studies and longer treatises. The longest paper in the volume, by Plowman, is a fascinating, detailed study of the history, taxonomy, cultivation, phytochemistry, and ethnobotany of two species and four varieties of coca, *Erythroxylum coca* and *E. novogranatense*. Other contributions that focus on the ethnobotany of various taxonomic groups include palms (Balick), manioc (Boster), Solanaceae (Heiser), and edible fungi (Prance). Ayala Flores presents a more generalized paper on Peruvian plants with medicinal or toxic properties. Lewis and Elvin-Lewis explore the realm of ethnodentistry, the use of botanical agents by the Jivaro for tooth extraction or hygienic blackening. The article by Posey on the agricultural ecology of the Kayapo examines the continuum between "domesticated" and "wild" plants and suggests that there is no clear-cut demarcation between "natural" and "managed" forest in much of Amazonia. Van den Berg's contribution includes an annotated "flora" of plants found in the open-air market in Belem, Brazil.

All too often, ethnoscientists are strangers to the area they are studying. Ayala Flores, Posey, and van den Berg are residents of the Neotropics. Berlin emphasizes the value of training local informants to gather ethnobiological specimens and data. This collaborative approach can provide a wealth of information and new insight into understanding a traditional culture's view of the natural world.

The overall layout of the volume is identical to its parent journal, *Economic Botany*. The only reservation I have about this publication is that $29.75 seems a little expensive for a journal as opposed to a book format. Nevertheless all researchers in the field of economic botany will look forward to the next issue of *Advances*.

CHM

J. Ethnobiol. 4(2): 141-169 December 1984

CHUMASH ETHNOBOTANY: A PRELIMINARY REPORT

JAN TIMBROOK
Department of Anthropology
Santa Barbara Museum of Natural History
2559 Puesta del Sol Road
Santa Barbara, CA 93105

ABSTRACT.—The Chumash, a hunting, gathering, fishing and seafaring people of coastal southern California, were greatly affected by Spanish missionization beginning in the 1770s. Mexican settlement and later Americanization exerted their own influences, and by the early 20th century the Chumash had been pushed nearly to the brink of extinction. Although the people survived physically, most of their culture perished. Recently, much has been learned about the early Chumash way of life through ethnographic and linguistic data which were collected while Chumash culture still lived in memory, combined with historic, archaeological, and museum resources. This paper summarizes what has thus far been reconstructed of Chumash knowledge and uses of plants in late prehistoric times and after European contact. Chumash ethnobotany has broader implications for theoretical issues in the nature of hunting-gathering societies, interpretation of the archaeological record, human ecology, acculturation, and folk taxonomic studies.

INTRODUCTION

At the time of the first Spanish voyages of discovery along the southern California coast, beginning with Cabrillo in 1542, the Santa Barbara Channel Islands, mainland coast, and adjacent interior mountains and valleys were occupied by about 15,000 people who later became known as the Chumash. Although never politically unified much beyond groups of villages, and that only in certain areas, they were culturally and linguistically similar enough to be considered by anthropologists as a single, albeit somewhat variable, cultural entity.

The climate of Chumash territory is of Mediterranean type, with warm dry summers and cool moist winters. Coastal temperatures (°F) average in the 40s in January, upper 60s in July. Diurnal and seasonal fluctuations in temperature are greater in the inland areas than along the coast. The rainy season, with average rainfall of about 43 cm at Santa Barbara, lasts from November to April. Virtually no precipitation occurs the rest of the year. Early summer fogs give way to late summer heat and drought, with occasional wildfires fanned by winds from interior deserts (Smith 1976:3-6).

The bulk of the Chumash population resided along the plain on the coastal side of the Santa Ynez Mountains. This range runs parallel to the east-west coastline, and rises to a height of some 1200 meters within just a few kilometers of the shore. Vegetation on the coastal plain was dominated by grassland-oak savannah. Coastal sage scrub and chaparral were also widespread plant communities; the latter is a dense growth of several species of stiff woody shrubs covering the slopes of the mountains and higher foothills. Numerous stream channels of both seasonal and permanent watercourses, lined with riparian vegetation, dissected the coastal plain. Stream channels often terminated in coastal marshlands. Inland, oak savannah and woodland dominated the valleys, with stands of coniferous trees in the higher mountains. Within a relatively short distance from any settlement there were a variety of different plant communities, each with its own set of valuable resources which contributed to the subsistence, material culture and religious behavior of the Chumash people.

The Chumash were hunter-gatherers, with particular emphasis on ocean fishing by coastal groups. The marine and terrestrial environments were both rich in species diversity and extraordinarily productive, permitting a sedentary settlement pattern and a degree of population density greater than that of most agricultural peoples in aboriginal North America (Brown 1967). Ethnohistoric research has revealed much about the complexity of Chumash society (e.g. Blackburn 1975, 1976; Harrington n.d.; King 1971), which was stratified into classes based on wealth; membership in these was inherited but some opportunities for mobility also existed. Positions of political and religious leadership were inherited. Craft specialization seems to have been controlled by guild-like organizations. Shell bead money functioned as a medium of exchange in a far-reaching network of trade. The Chumash, in short, were a prime example of what have been called "affluent foragers" (Koyama and Thomas 1981) and were not at all typical of the more familiar modern, nomadic hunter-gatherers who have been pushed into marginal environments.

Technologically sophisticated though they were, the Chumash proved no match for the powerful ecclesiastical and military force of the Spanish Empire, nor for the array of contagious diseases which devastated their population and their morale. Although the Mission system, which lasted from 1770 to 1834, was apparently less completely destructive to Chumash culture than was once thought, it so drastically reduced their numbers and altered their outlook that it was impossible to revive the functioning cultural entity after secularization. The Mexican rancho era (1834-1850) and subsequent period of American settlement further contributed to the numerical and cultural decline of the Chumash. Although there are over a thousand people of Chumash ancestry currently residing in Santa Barbara, Ventura and San Luis Obispo counties—the approximate extent of their former territory—Chumash culture may be regarded as virtually extinct.

SOURCES AND METHODS

Because of the lack of knowledge about nearly all traditional plant uses and related lore among today's Chumash descendants, the usual methods of ethnographic and linguistic field work are not useful for gathering information about former practices. Reconstruction of pre-contact and early historic Chumash ethnobotany is therefore a task requiring the pragmatic research method often labeled "ethnohistory." This term may cause some confusion since it is qualitatively different from "ethnobotany," "ethnomusicology," and the like. It has been characterized as the history of non-literate peoples and fundamentally involves incorporation of a diverse variety of sources (Carmack 1972). For this specific research project there are three major sources: historical writings by early travelers and missionaries; unpublished notes from ethnographic and linguistic field work which was conducted early in this century; and archaeological findings, including collections now housed in museums. In addition, a general familiarity with cultural patterns and plant usages throughout the entire central and southern Californian culture area is incorporated, in order to provide a basis for comparison and a context for interpretation of the findings from the other major sources.

The brief logs of the 1542 Cabrillo voyage, which marked the initial contact between Chumash and Europeans, provide very little detail; and subsequent contacts over the next two centuries were few and sporadic (Bolton 1925; Wagner 1929). The major historic sources which provide information about Chumash plant uses begin with the diaries of the Portolá and De Anza expeditions of 1769-1770, particularly the accounts by Crespí (Bolton 1927; Brown n.d., 1965) and Fages (Priestley 1937). These accounts paid much attention to natural resources, with an eye toward establishing Spanish colonies, and therefore contain information about the relationship between native peoples and flora. Further such information is offered by later naturalist-explorer José Longinos Martínez in 1792 (Simpson 1961) and by Archibald Menzies on the Vancouver expedition a year later (Menzies 1924). By that time Franciscan missions had already been established, certain species of new plants introduced, and traditional Chumash plant-use practices subjected to Spanish-Mexican influence. Writings by the missionaries provide ethnobotanical data, particularly on food and medicine; they are noticeably sparse on material culture and religion, things the padres sought to change rather than understand (Geiger and Meighan 1976). After mission secularization in 1834 there are few historical documents of much use for ethnobotanical reconstruction. Exceptions are two manuscripts on Chumash medicine, one compiled in the late 19th century by a physician (Bard 1894), the other slightly later by a pharmacist (Birabent n.d.).

The bulk of the data available on Chumash ethnobotany comes from field work conducted by the Bureau of American Ethnology anthropologist and linguist, John P. Harrington. He worked sporadically with at least three generations of Chumash consultants from about 1912 into the 1950s, although he collected most of the information in the 1910s and 20s.[1] Plant usages and names in five Chumashan languages as well as Spanish and English are scattered throughout Harrington's tens of thousands of pages of field notes. In addition, several hundred plant specimens were collected by some of his consultants and tagged with Barbareño Chumash and Spanish common names.[2] Because Harrington usually attempted to note names for the same plant in several Chumashan languages and Spanish, these tagged specimens have enabled accurate botanical identification of numerous plants for which Chumash or Spanish common names prevail, both in his own notes and in many other sources. The Harrington material provides a good core of data on Chumash knowledge and uses of plants into which data from other historical, ethnographic, and archaeological sources can be fitted. In this way, a reasonably detailed picture can be obtained, although it will never be as complete as one which incorporates first-hand fieldwork directed toward ethnobotanical inquiry.

The archaeological record is likewise incomplete, because of poor preservation of plant remains and, until recently, poor techniques for their recovery. This research project has to date directed little attention toward investigation of archaeological plant remains; a large body of site reports awaits perusal. It seems likely that interpretation of archaeological findings will gain in significance when ethnobotanical data from other sources have been compiled and species taxonomically determined. Museum collections do contain both archaeological and ethnographic artifacts and raw materials which are proving useful in supplementing and clarifying data from other sources; examples include wooden bowls, canoe planks, basketry, and caches of medicinal plants.

The ideal method for reconstructing late prehistoric and early historic period Chumash ethnobotany would be to start with the earliest information available and describe changes that occurred in chronological order. This may in fact turn out to be the best way of presenting the information. Unfortunately, the data from early historic times are extremely scanty. The most complete source is the "memory ethnography" conducted after 1910, which reaches only slightly further back than the mission era with any certainty. Accordingly, the constraints of the source materials available force adoption of the so-called "direct historic approach" pioneered by Strong (1940) in Plains ethnohistory, among other authors (e.g. Steward 1942); it consists of working backward in time from the known to the unknown.

One possible drawback of the direct historic approach in Chumash ethnobotanical research is a propensity to what might be called "reconstruction by subtraction." It is tempting merely to eliminate species which are known to have been introduced from the Mediterranean Region in order to arrive at what was presumably the aboriginal tradition. But this results in two serious problems: first, it overlooks the more subtle influences which may have been exerted on plant usages beyond simple introduction of species; and second, it implicitly assumes that aboriginal tradition was static, extending unaltered into the indefinite distant past. To the contrary, contacts between groups as well as outright population movements existed prehistorically, not just after European arrival; particular consideration must be given to the date of any piece of information in order to attempt to fit it into this dynamic process of culture change. It is likely, though, that there would have been a relatively stable core of plant usages and related practices that were maintained fairly consistently over the period of a few centuries intended to be covered in this study. It should be possible to determine these by comparing source materials which date from different time periods.

SUMMARY OF THE FINDINGS

Plants which I have thus far determined to have been used by the Chumash are listed in the Appendix at the end of this article.[3] Their uses are assigned to standardized, general categories and subcategories to facilitate summarizing a large body of information. More complete descriptions of specific usages, plant parts used, methods of preparation, season of gathering, and other such important topics will be included in a comprehensive monograph which will be published in the future. Vernacular names in the five major Chumashan languages and in the local Spanish dialect are likewise too cumbersome to include in the present format.

Plants for which uses are listed number 156 species, of which 16 are non-native. Of the many plants which were introduced to California from elsewhere and adopted by the Chumash, only those which have become naturalized are included here. Because it is not always clear exactly which of the species in a particular genus were used or not used, the figures are only approximations, but the data presented in the Appendix are roughly summarized in Table 1. Since many plants have more than one use—several have six or seven, oaks and willows have ten or 11—the subcategory figures total higher than the number shown for each major heading.

One difficulty with this scheme for summarizing a very large body of data is that it is hard to see which species were really the most important, in terms of quantities which

TABLE 1. Summary of Chumash plant usages.

Category	Native spp.	Introd. spp.	Total
Food	55	10	65
Medicine	88	9	97
curing	86	9	95
hygiene	10	0	10
Material Culture	60	3	63
clothing	16	1	17
construction	19	2	21
crafts	46	2	48
tools	27	2	29
Ceremonial	36	1	37
religious	25	0	25
magical	17	0	17
amusements	18	1	19
Miscellaneous	22	3	25

may have been used or key roles which they may have played despite small volume obtained. To help balance the tendency toward numerical interpretation of data, which, if carried to excess, may be seriously misleading, I insert here a brief commentary on what I subjectively consider to have been the 20 most important plants in Chumash culture. They are listed taxonomically rather than in order of importance.

1. Pines, particularly piñon *(Pinus monophylla)* but also *P. ponderosa* and *P. jeffreyi,* provided nuts which were a major storable food, pitch as an adhesive and caulking material, and wood for construction and bowmaking.

2. Giant wild rye *(Elymus condensatus)* and carrizo grass *(Phragmites australis)* were most valued for arrowmaking, but also had several other uses. Honeydew deposited on carrizo was a particular delicacy.

3. Bulrush *(Scirpus* spp.) stems were the principal material for mats and house thatching; the rhizomes were also eaten.

4. *Juncus* rush (four species) was virtually the only plant used in basketmaking. Chumash baskets served in numerous vital roles in daily life, as well as being a highly developed art form.

5. Soaproot *(Chlorogalum pomeridianum)* bulbs were used as fish poison, and possibly as human food; the outer husk fibers were made into utilitarian brushes.

6. Brodiaea *(Dichelostemma pulchellum)* bulbs were formerly much more common than they are today and were apparently a major food.

7. *Yucca whipplei* was important as a fiber, food, and fuel plant. Early Spanish explorers were offered roasted yucca "cabbages" and found them quite delicious.

8. Willows, probably several species, constituted the most important material for fuel and for all kinds of construction; e.g., willow poles were lashed with willow bark to form the house framework. They also had a number of medicinal uses.

9. Oaks, particularly *Quercus agrifolia* and *Q. lobata,* yielded acorns which were unquestionably the most important staple food of the Chumash. Their value was due both to abundance and to storability. Oaks had many other uses as well–some 11 are listed in the Appendix–including importance as firewood and coals for toasting seeds.

10. Red maids *(Calandrinia)* seeds were very important as offerings on religious occasions. Large quantities of these small, black seeds have been found as burial accompaniments throughout Chumash territory.

11. ***Toyon*** *(Heteromeles arbutifolia)* provided hard wood used for arrow foreshafts and many other kinds of tools.

12. Wild cherry *(Prunus ilicifolia)* pits were another abundant, storable staple food.

13. Ceanothus and probably also mountain mahogany *(Cercocarpus betuloides)* wood was made into digging sticks, essential tools for harvesting many edible plants.

14. Prickly pear cactus *(Opuntia* spp.) had among the most diverse uses of any plant: fruit and stems as food, thorns for ear piercing, juice for medicine and dye.

15. ***Chuchupate*** *(Lomatium californicum)* root was a highly valued magical plant especially for affording protection from rattlesnakes.

16. Indian hemp *(Apocynum cannabinum)* and to a lesser extent milkweed *(Asclepias* spp.) fiber was most important for making string and cordage. These were essential for canoemaking, fishing lines, nets, clothing, and other necessities of life.

17. Chia sage *(Salvia columbariae)* seeds were a major food, constantly mentioned by Harrington's Chumash consultants and many other historical sources. These seeds also had medicinal uses. Other species of *Salvia* seem to have been much less used.

18. Jimsonweed or ***toloache*** *(Datura meteloides)* was the single most important ceremonial/religious plant. It induced visions enabling contact with the supernatural, and was also extensively used in curing.

19. Native tobacco *(Nicotiana* spp.) was used for ceremonial purposes, as well as being smoked or eaten for enjoyment and health.

20. *Artemisia californica* and *A. douglasiana* both had several uses, the former principally for ritual and ceremony, the latter as medicine.

It will be noted that there are few medicinal plants named in the above list. This is not because I doubt the efficacy of native health care practices, but because it is difficult to assess their importance when little information is available about how frequently Chumash people resorted to herbal medicine.

DISCUSSION

Following the brief overview just presented of the range of plant usages by the Chumash, in this section I will address three related topics which have emerged in the course of this research. First, how did contact with Europeans and the species they introduced affect Chumash plant use practices? Second, how did the Chumash think about plants and categorize them? What if any correlation exists between Chumash folk taxonomy and the Linnaean system? Third, what other kinds of plant-human interactions can be suggested? That is, in connection with being gatherers of plants, how did the Chumash as hunter-gatherers affect the ecological system in which they lived?

As might be expected, the highest proportion of introduced plants is seen in the food and medicine categories. The large total number of medicinal plants (97 spp.) may be related to the many uses that were introduced to the Chumash in the mission era for plants which were native over a wide area from Mexico to southern California. Studies in recent decades (e.g. Gardner 1965, Weyrauch 1982) indicate that the Chumash, like most peoples, have probably always been willing to try new remedies, especially for colds and for the dermatitis induced by poison oak. It seems very likely that even though medicinal plants may have a wide distribution, their uses may have been discovered by peoples in some parts of the range but not in others. Hispanic folk medicine undoubtedly had a significant influence on Chumash practices from very early historic times.

New dietary items introduced with the agricultural mission economy had a profound effect on the inventory of Chumash food plants which is scarcely reflected in the numbers presented here, owing to the elimination of cultivars from the list. Leaving those plants aside and focusing only on naturalized species, which behave like native plants in "just growing wild," it is clear that the Chumash readily adopted those which were most like plants they were already using. These included small seeds of annual grasses, dock and mustard; fresh greens of mustard, watercress and mallow; and the larger, less spiny fruit and pads of *Opuntia ficus-indica,* a species which hybridized with the native prickly pears.

The same can be said of plants used in material culture: new species were adopted to fill the same functions as the native plants to which they were most similar. There were only three species which were introduced into material culture, with seven uses among them. Giant reed *(Arundo donax)* supplemented the large native wild rye and carrizo grasses in construction, arrowmaking and other crafts. The large introduced prickly pear cactus joined its native counterparts in being used for paint, sealant and other things as well as for food and medicine. Finally, mallow was found to be suitable for stringmaking, although it was considered inferior to Indian hemp, milkweed and nettle.

In ceremonial categories, however, the evidence indicates that no introduced species were adopted into either religious or magical functions. This is to be expected owing to the greater conservatism and importance of tradition in those aspects of life, in contrast to pragmatic willingness to experiment with foods and remedies. The only introduced plant in the amusement category was, again, giant reed, which was used like carrizo grass for cigarette-like tubes to hold smoking tobacco.

The number of native species in the list should be expanded somewhat after further study of the source materials and comparison with known plant use patterns of neighboring groups in the wider culture area. It now seems as though several species which the Chumash would be expected to have used are not mentioned, particularly numerous species of native bunch grasses and seed-bearing composites. These gaps can probably be attributed principally to the small sample of consultants interviewed by Harrington, the late date of his study after many traditional usages had been forgotten, and the fact that his salvage ethnography was quite wide-ranging rather than focused on ethnobotany.

The degree of correlation between Chumash folk botanical taxa and Western scientific genera and species must be addressed in any study such as this. Chumashan languages are no longer spoken and there are no knowledgeable consultants who can aid in folk taxonomic inquiries. It has therefore been a matter of real concern that a researcher trained to think in terms of Linnaean taxonomy could completely misinterpret or at least seriously misunderstand the categories of organisms represented by Harrington's recorded Chumash names.

Careful analysis of plant descriptions included in Harrington's field notes and of the labeled, pressed specimens collected by his consultants has relieved much of my anxiety on that score. As Berlin and his colleagues (Berlin 1973; Berlin et al. 1973, 1974) have found with other peoples, the Chumash seem to have fairly consistently placed plants into categories that bear a remarkable similarity to our own, and to have based them on morphological features in most cases. To give three examples: they distinguished[4] between spiny gooseberries (***stɨmɨy***, *Ribes amarum;* ***stɨmɨy 'iwɨ***, *R. speciosum)* and non-spiny currants *(**sqa'yi'nu**,* characterized as "smooth," attributed to *R. malvaceum),* reflecting a division made by some authors, *Ribes* and *Grossularia* spp.; between white-flowered *(**seq**, Ceanothus megacarpus)* and blue-flowered (***washiko***, *C. oliganthus, C. spinosus)* groups of Ceanothus; and between the evergreen coast liveoak (***ku'w***, *Quercus agrifolia)* and deciduous valley oak (***ta'***, which includes both *Q. lobata* and the deciduous, lobed-leaved *Q. dumosa* var. *kinselae).*

Other factors are sometimes seen in Chumash plant categorization. Usage is reflected in the fact that separate names were given to taxa used for coiled basketry foundations (Ventureño ***tash***), for sewing strands (***mexme'y***), and for twined basketry (***'esmu***); however, even in this case the divisions also seem to coincide with Western species (attributed to *Juncus balticus, J. textilis,* and *J. acutus,* respectively, from descriptions by Harrington's consultants). Habitat may sometimes be invoked in distinguishing between similar plants. For example, *Equisetum telmateia* var. *braunii* and *Ephedra viridis,* superficially similar in having jointed stems, were both called ***woshko'loy*** in Barbareño Chumash, but the latter was distinguished with a suffix indicating the interior mountain range where it was found: ***woshko'loy "hi cimajimol"*** [sic] = ***'i tsiwaya*** (?) [***tsiwaya***, San Emigdio Mountain (Applegate 1975:44)].

Cultural ecology deals with the interrelationships between people and plants. The above discussion has already addressed some of the effects of plants on the Chumash people in terms of their usage and classification. The effects that people have on plants can be either deliberate or unintentional. Gathering plants for human use is a deliberate act which may have unintentional effects, such as depletion of fuelwood; to date no evidence has been found that the Chumash "overexploited" any plant species. Long-term habitation in particular sites has resulted in formation of the distinctive midden soil, which tends to be colonized by certain species of plants. Although most of Chumash habitat has been extensively altered by recent suburban development, the Channel Islands are relatively undisturbed. On Santa Cruz Island, native tobacco is only found on middens of former village sites, and *Datura* is found in far greater concentrations there than in any other location. Both these plants were of great importance in Chumash religion and ceremony. I suspect that they were introduced to the islands by the Chumash, although fertility or chemistry of the soil may also have some bearing on their preference for colonizing middens. The intended or accidental effects humans had on the distribution of such plants is a question that ethnobotanical research should not overlook.

It has recently been found that the Chumash may have performed significant environmental alterations through the practice of regular burning of grasslands to encourage growth of certain plants which provided human food (Timbrook et al. 1982). By doing this, they affected not only the abundance and vigor of the particular species they sought, but probably had significant effects on the distribution of whole communities or types of vegetation as well. Archaeologists should attempt to recover plant remains and any other data which can yield information about the antiquity of this practice, and also about whether the Chumash may have acted as a selective influence on the morphology as well as on the distribution of the plants they used. Agricultural peoples have modified the plants they use, even those which are not really domesticated (see, e.g., Bye 1981; Nabhan et al. 1981). It is possible that some hunter-gatherers may have had similar effects on their botanical environment.

CONCLUSION

The Chumash are of interest for cultural ecological studies, for at least two reasons: their high population density was supported exclusively by an economic base of hunting, fishing, and gathering wild plants; and they actively manipulated their environment to increase their base of support. Greater knowledge of Chumash ethnobotany, along the lines suggested here, can contribute to a better general understanding of the interdependent relationships between human populations and their natural environment.

In folk taxonomic research, it is useful to have new information to suggest that one more group of people tended to classify plants according to the same morphological criteria which have formed the basis for Western "scientific" taxonomy, fitting into the general pattern noted by Berlin, Raven and others (Berlin 1973; Berlin et al. 1973, 1974; Raven et al. 1971). For the Chumash, this remains only a suggestion since the original data are incomplete, and prehispanic language and folk categories are unknown among today's descendants.

Study of any people's plant knowledge and uses are also of great potential importance for understanding the processes of culture contact and change, and how they affect the mechanics of everyday life. The Chumash case offers excellent opportunities for such research, and offers a model for the use of archival sources in ethnobotanical investigation.

ACKNOWLEDGEMENTS

My continuing research with the Harrington collection could not have been nearly so rewarding without the invaluable assistance of the staff of the National Anthropological Archives, particularly Elaine Mills, Harrington Microfilm Project Archivist. I am also most grateful to botanists Clifton Smith of this museum and Mary Junak, Steve Junak, Ralph Philbrick and Steve Timbrook of the Santa Barbara Botanic Garden, for their ability to recognize plant species from 60-year-old dried fragments. This research has been funded in part by grants from the Smithsonian Institution and the University of California, Santa Barbara, with continuing support by the Santa Barbara Museum of Natural History. An abbreviated version of this paper was presented at the Seventh Ethnobiology Conference in Seattle, April 1984; subsequent comments by the editor of this journal and two anonymous reviewers were most helpful in adapting it for publication.

LITERATURE CITED

ANDERSON, EUGENE N., JR. 1978. A Revised, Annotated Bibliography of the Chumash and their Predecessors. Ballena Press Anthropological Papers No. 11, Socorro, New Mexico.

APPLEGATE, RICHARD. n.d. Ineseño Chumash Dictionary. Unpublished manuscript on file, Santa Barbara Museum of Natural History Library.

__________. 1975a. An Index of Chumash Placenames. Pp. 19-46, *in* Papers on the Chumash. San Luis Obispo County

LITERATURE CITED (continued)

Archaeological Society Occasional Paper No. 9. San Luis Obispo.

____________. 1975b. The Datura Cult Among the Chumash. Journal of California Anthropology 2(1):7-17.

BARD, CEPHAS L. 1894. A Contribution to the History of Medicine in Southern California. Southern California Practitioner, August 1894.

BELL, K.M. 1931. Swinging the Censer. Privately Printed, Santa Barbara.

BERLIN, BRENT. 1973. Folk Systematics in Relation to Biological Classification and Nomenclature. Annual Review of Ecology and Systematics 4:259-271.

BERLIN, BRENT, DENNIS E. BREEDLOVE, and PETER H. RAVEN. 1973. General Principles of Classification and Nomenclature in Folk Biology. American Anthropologist 75:214-242.

____________. 1974. Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-Speaking Community of Highland Chiapas. Academic Press, New York

BINGHAM, MRS. R.F. 1890. Medicinal Plants Growing Wild in Santa Barbara and Vicinity. Santa Barbara Society of Natural History Bulletin 1(2):34-37.

BIRABENT, FRANK. n.d. Wild Herbs Used by the Indians and Spanish People in Santa Barbara County for Medicinal Purposes. Manuscript on file, Santa Barbara Museum of Natural History Library.

BLACKBURN, THOMAS C. A Manuscript Account of the Ventureño Chumash. Archaeological Survey Annual Report, 1962-1963, pp. 135-160. University of California, Los Angeles.

____________. 1975. December's Child: A Book of Chumash Oral Narratives. University of California Press, Berkeley.

____________. 1976. Ceremonial Integration and Social Interaction in Aboriginal California. Pp. 225-243 *in* Native Californians: A Theoretical Retrospective, L.J. Bean and T.C. Blackburn, eds.

BOLTON, HERBERT E. 1925. Spanish Exploration in the Southwest, 1542-1706. Charles Scribner's Sons, New York.

____________. 1927. Fray Juan Crespí, Missionary Explorer on the Pacific Coast. University of California Press, Berkeley.

BROWN, ALAN K. n.d. Unpublished Translation of Portions of Crespí's Journals. Manuscript on File, Santa Barbara Mission-Archive Library, reference file ms. 720.

____________. 1965. The Various Journals of Juan Crespí. The Americans 21(4): 375-398.

____________. 1967. The Aboriginal Population of the Santa Barbara Channel. University of California Archaeological Survey Reports No. 69, Berkeley.

BYE, ROBERT A., JR. 1981. Quelites–Ethnoecology of Edible Greens–Past, Present, Future. Journal of Ethnobiology 1(1):109-123.

CABALLERÍA Y COLLELL, JUAN. 1892. History of the City of Santa Barbara, California. F. de P. Gutierrez, Santa Barbara.

CARMACK, ROBERT M. 1972. Ethnohistory: A Review of its Development, Definitions, Methods and Aims. Annual Review of Anthropology 1:227-246.

CRAIG, STEVE. 1966. Ethnographic Notes on the Construction of Ventureño Chumash Baskets: From the Ethnographic and Linguistic Field Notes of John P. Harrington. Archaeological Survey Annual Report 8:197-214. University of California, Los Angeles.

____________. 1967. The Basketry of the Ventureño Chumash. Archaeological Survey Annual Report 9:78-149. Univ. California, Los Angeles.

DAWSON, LAWRENCE and JAMES DEETZ. 1965. A Corpus of Chumash Basketry. Archaeological Survey Annual Report 7:193-276. University of California, Los Angeles.

GARDNER, LOUISE. 1965. The Surviving Chumash. Archaeological Survey Annual Report 7:277-302. University of California, Los Angeles.

GEIGER, REV. MAYNARD J., and CLEMENT MEIGHAN. 1976. As the Padres Saw Them: California Indian Life and Customs as Reported by the Franciscan Missionaries, 1813-1815. Santa Barbara Mission Archive-Library, Santa Barbara.

GRANT, CAMPBELL. 1964. Chumash Artifacts Collected in Santa Barbara County, California. Archaeological Survey Reports 63:1-44. University of California, Berkeley.

GREENWOOD, ROBERTA. 1972. Nine Thousand Years of Prehistory at Diablo Canyon, San Luis Obispo County, California. San Luis Obispo County Archae-

LITERATURE CITED (Continued)

ological Society Occasional Paper No. 7. San Luis Obispo.

HARRINGTON, JOHN P. n.d. Unpublished Ethnographic and Linguistic Field Notes. Manuscripts on file, National Anthropological Archives, Smithsonian Institution.

__________. 1928. The Mission Indians of California. Pp. 173-178, *in* Explorations and Field Work of the Smithsonian Institution in 1927. Smithsonian Institution, Washington, D.C.

__________. 1934. Rescuing the Early History of the California Indians. Pp. 54-56, *in* Explorations and Field Work of the Smithsonian Institution in 1933. Smithsonian Institution, Washington, D.C.

__________. 1942. Culture Element Distributions: XIX. Central California Coast. University of California Archaeological Reports 7(1):1-46. University of California, Berkeley.

__________. 1944. Indian Words in Southwest Spanish, Exclusive of Proper Nouns. Plateau 18(2):27-40.

HEIZER, ROBERT F. (ed.) 1955. California Indian Linguistic Records: the Mission Indian Vocabularies of H. W. Henshaw. Anthropological Records 15:85-202. University of California, Berkeley.

__________. 1970. More J. P. Harrington Notes on Ventureño Chumash Basketry and Culture. Archaeological Research Facility Contributions 9:59-73.

HENSHAW, HENRY W. 1885. The Aboriginal Relics Called "Sinkers" or "Plummets." American Journal of Archaeology 1(2):105-114.

HUDSON, TRAVIS. 1977. Chumash Wooden Bowls, Trays, and Boxes. San Diego Museum Papers No. 13. San Diego.

HUDSON, TRAVIS and THOMAS C. BLACKBURN. n.d. Chumash Material Culture, forthcoming volumes. Manuscript on file, Santa Barbara Museum of Natural History Library.

__________. 1982. The Material Culture of the Chumash Interaction Sphere, Vol. I: Food Procurement and Transportation. Ballena Press Anthropological Papers No. 25. Los Altos.

__________. 1983. The Material Culture of the Chumash Interaction Sphere, Vol. II: Food Preparation and Shelter. Ballena Press Anthropological Papers No. 27. Los Altos.

HUDSON, TRAVIS, THOMAS BLACKBURN, ROSARIO CURLETTI, and JAN TIMBROOK. 1977. The Eye of the Flute: Chumash Traditional History and Ritual as Told by Fernando Librado *Kitsepawit* to John P. Harrington. Santa Barbara Museum of Natural History, Santa Barbara.

HUDSON, TRAVIS, JAN TIMBROOK, and MELISSA REMPE. 1978. *Tomol:* Chumash Watercraft as Described in the Ethnographic Notes of John P. Harrington. Ballena Press Anthropological Papers No. 9. Socorro.

JEPSON, WILLIS L. 1925. A Manual of the Flowering Plants of California. University of California Press, Berkeley.

__________. 1936. A Flora of California, Vol. II: Capparidaceae to Cornaceae. California School Book Depository, San Francisco.

__________. 1943. A Flora of California, Vol. III, Part 2: Convolvulaceae to Solanaceae. Associated Students Store, University of California, Berkeley.

KING, CHESTER. 1971. Chumash Intervillage Economic Exchange. The Indian Historian 4(1):31-43.

KOYAMA, SHUZO and DAVID H. THOMAS. 1981. Affluent Foragers: Pacific Coasts East and West. Senri Ethnological Series 9. Osaka, Japan.

KROEBER, ALFRED L. 1908. A Mission Record of the California Indians. University of California Publications in American Archaeology and Ethnology 8(1):1-27. Berkeley.

MENZIES, ARCHIBALD. 1924. Journal of the Vancouver Expedition, Alice Eastwood, ed. California Historical Society Quarterly 2:264-340.

MUNZ, PHILIP A. (in collaboration with David D. Keck). 1959. A California Flora. University of California Press, Berkeley.

NABHAN, GARY, ALFRED WHITING, HENRY DOBYNS, RICHARD HEVLY, and ROBERT EULER. 1981. Devil's Claw Domestication: Evidence from Southwestern Indian Fields. Journal of Ethnobiology 1(1):135-164.

PRIESTLEY, H. I. (ed., tr.). 1937. A Historical, Political, and Natural Description of California. University of California Press, Berkeley.

RAVEN, PETER, BRENT BERLIN, and DENNIS E. BREEDLOVE. 1971. The Origins of Taxonomy. Science 174:1210-1213.

ROTHROCK, J. T. 1876. Observations upon the Economic Botany and Agriculture of Portions of Southern California. Appendix H-5, pp. 202ff., *in* Annual Report Upon the Geological Surveys West of the One Hundredth Meridian. Government Printing Office, Washington, D.C.

__________. 1878. Notes on Economic Botany. Pp. 39-52, *in* United States Geographical Surveys West of the One Hundredth Meridian, Vol. VI: Botany. Government Printing Office, Washington, D.C.

SIMPSON, L. B. (ed., tr.). 1961. The Journal of José Longinos Martinez. John Howell Books, San Francisco.

SMITH, CLIFTON F. 1976. A Flora of the Santa Barbara Region, California. Santa Barbara Museum of Natural History, Santa Barbara.

STEWARD, JULIAN H. 1942. The Direct Historical Approach to Archaeology. American Antiquity 7:337-343.

STRONG, WILLIAM D. 1940. From History to Prehistory in the Northern Great Plains. Pp. 353-394 *in* Essays in Historical Anthropology of North America. Smithsonian Miscellaneous Collections Vol. 100. Smithsonian Institution, Washington, D.C.

TIMBROOK, JAN. 1982. Use of Wild Cherry Pits as Food by the California Indians. Journal of Ethnobiology 2(2):162-176.

__________, JOHN R. JOHNSON, and DAVID D. EARLE. 1982. Vegetation Burning by the Chumash. Journal of California and Great Basin Anthropology 4(2):163-186.

WAGNER, HENRY R. 1929. Spanish Voyages to the Northwest Coast of America in the Sixteenth Century. California Historical Society, San Francisco.

WALKER, PHILLIP and TRAVIS HUDSON. (In press). Chumach Healing: Changing Medical Practices in an American Indian Community. Malki Museum Press, Banning.

WEBB, EDITH B. 1952. Indian Life at the Old Missions. Warren F. Lewis, Los Angeles.

WEYRAUCH, RITA. 1982. Herbal Remedies. Solstice Journal 1(1). Santa Barbara Indian Center, Santa Barbara.

YARROW, H. C. 1879. Report on the Operations of a Special Party for Making Ethnological Researches in the Vicinity of Santa Barbara, Cal. Pp. 32-47 *in* Report Upon the United States Geographical Surveys West of the One Hundredth Meridian, Vol. VII: Archaeology. Government Printing Office, Washington, D.C.

NOTES

[1]Though Harrington managed to publish only one major work on the Chumash (a culture trait list, Harrington 1942), his unpublished field notes have proved to be a gold mine of information on all aspects of Chumash language and culture which is being tapped by a new generation of researchers (for a partial list, see Anderson 1978). The field notes, related documents and plant specimens from Harrington's work with Indian peoples all over North America are housed at the National Anthropological Archives, Smithsonian Institution, Washington, D.C. Microfilm copies of much of this material are being made available.

[2]Although the specimens were generally in poor condition, I was able to identify most of them by sight or with the aid of standard reference floras (Munz 1959; Jepson 1925; Smith 1976). These attributions were confirmed, and additional identifications made, by botanists visiting from the Santa Barbara Botanic Garden who are much more expert than I in dealing with dried material. The collections of the U.S. National Herbarium were also used for species comparison in some instances. Since all but a few of Harrington's Chumash plant specimens were collected in the 1920s by a single Barbareño consultant, they only represent her knowledge and those species which were available in a small part of coastal Chumash territory. In earlier times it was common for people to travel inland to collect many other very important species not available near the coast.

[3]These determinations were made using various combinations of the following: actual labeled plant specimens; descriptions in Harrington's notes or other sources; common names in Chumashan languages, English or local Spanish dialects; study of artifacts made from plants. The attributions are generally very conservative, and many more species were probably used than are shown here.

[4]Unless otherwise noted in the text, the terms given are from the Barbareño Chumash language, and the identifications are from specimens. The orthography follows the practical system designed by Applegate (1975a), with the substitution of x for underlined h to minimize typesetting difficulties.

APPENDIX
Plants Used by the Chumash

A few introductory comments are necessary to explain what is included in this appendix, what is omitted, and what sources were consulted.

The list includes only those identified species for which Chumash usages were mentioned in one or more of the 50 references which are enumerated below. Most of the information was obtained through firsthand study of John P. Harrington's notes and plant specimens; that which came from research by other authors based on the Harrington material was carefully evaluated—and some identifications changed—before being included. Many other ethnographic, botanical and historical sources were also consulted and similarly evaluated.

Certainly many more species were likely to have been used than the information available at this late date would indicate, and some of the plants in the list may have had additional uses which were not mentioned in the sources I have examined. Naturalized species are included, but cultivars are not. The list omits the many plants which were only named, described, or collected and preserved as specimens, if no use was recorded for them. And plants which have not been botanically identified are also omitted, even though uses were mentioned. The plants are listed by family, genus and species, following the arrangement given in Smith's (1976) flora of the Chumash area.

SOURCES CITED IN THE APPENDIX

1. Author's analysis of material objects
2. Applegate n.d.
3. Applegate 1975a
4. Applegate 1975b
5. Bard 1894
6. Bell 1931
7. Bingham 1890
8. Birabent n.d.
9. Blackburn 1963
10. Blackburn 1975
11. Bolton 1925
12. Bolton 1927
13. Caballeria y Collell 1892
14. Centeno, Juanita: pers. comm. 1978
15. Craig 1966
16. Craig 1967
17. Dawson and Deetz 1965
18. Gardner 1965
19. Geiger and Meighan 1976
20. Grant 1964
21. Greenwood 1972
22. Harrington n.d.
23. Harrington 1928
24. Harrington 1934
25. Harrington 1942
26. Harrington 1944
27. Heizer 1955
28. Heizer 1970
29. Henshaw 1885
30. Hudson 1977
31. Hudson & Blackburn n.d., 1982, 1983
32. Hudson et al. 1977
33. Hudson, Timbrook & Rempe 1978
34. Jepson 1925
35. Jepson 1936
36. Jepson 1943
37. Kroeber 1908
38. Menzies 1924
39. Munz 1959
40. Priestley 1937
41. Rothrock 1876, 1878
42. Simpson 1961
43. Smith 1976
44. Timbrook 1982
45. Timbrook, Johnson & Earle 1982
46. Wagner 1929
47. Walker & Hudson in press
48. Webb 1952
49. Weyrauch 1982
50. Yarrow 1879

APPENDIX 1. *Plants Used by The Chumash.*

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
Macrocystis pyrifera	1	—	—	—	—	—	—	—	—	X	—	anchor	2, 22, 31
POLYPODIACEAE													
Dryopteris arguta	3	—	X	—	—	—	—	—	—	—	—	—	5, 8, 18, 21, 22, 47, 49
Pteridium aquilinum	3	—	—	—	—	X	X	—	—	—	—	—	17, 22
EQUISETACEAE													
Equisetum spp.	1	—	X	—	—	—	X	—	—	—	—	—	22
PINACEAE													
Pinus monophylla	0	X	—	—	—	—	X	X	—	—	—	fuel	2, 3, 8, 22, 28, 31, 32, 33, 49
P. jeffreyi	0	X	X	—	—	X	X	—	—	—	—	—	
P. ponderosa	0	X	X	—	—	X	X	—	—	—	—	—	
TAXODIACEAE													
Sequoia sempervirens[a]	0	—	—	—	—	X	—	—	X	—	—	—	3, 22, 32, 33
CUPRESSACEAE													
Juniperus californica	0	X	X	—	—	—	—	X	—	—	—	—	3, 5, 13, 19, 22, 26

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
EPHEDRACEAE													
Ephedra viridis	1	–	X	–	–	–	X	–	–	–	–	–	5, 8, 14, 18, 20, 21, 22, 43, 49
TYPHACEAE													
Typha sp.	2	X	–	–	–	X	X	–	–	–	–	–	3, 22
T. domingensis	1	X	–	–	–	X	X	–	–	–	–	–	
ZOSTERACEAE													
Phyllospadix torreyi	0	–	X		X	X	X	–	–				1, 8, 22, 31, 47
POACEAE													
Arundo donax (I)	0	–	–	–	–	X	X	X	–	–	X	–	22, 43, 48
Avena fatua (I)	1	X	–	–	–	–	–	–	–	–	–	fodder	2, 22
Bromus spp. (I)	2	X	–	–	–	–	–	–	–	–	–	–	2, 22
Distichlis spicata	0	X	–	–	–	–	–	–	–	–	–	–	2, 22
Elymus condensatus	3	–	–	–	X	X	–	X	–	–	X	–	1, 9, 22, 24, 25, 31
Muhlenbergia rigens	0	–	–	–	–	–	X	–	–	–	–	–	1, 17, 20, 25
Phragmites australis	0	X	X	–	–	–	X	X	X	–	X	–	22, 25, 31, 32, 43

APPENDIX 1. *Plants Used by the Chumash (continued)*

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
CYPERACEAE													
Carex spp.	0	–	–	–	–	–	X	–	–	–	–	–	17
Scirpus acutus	0	X	X	–	X	X	X	–	X	–	X	–	1, 2, 3, 5, 9, 17, 22, 25, 27, 31, 38
S. californicus	0	X	X	–	X	X	X	–	X	–	X	–	
JUNCACEAE													
Juncus acutus	0	–	–	–	–	–	X	–	–	–	–	–	1, 3, 9, 14, 15, 16, 17, 20, 21, 22, 25, 28, 31, 43
J. balticus	0	–	–	–	–	–	X	–	–	–	–	–	
J. effusus	0	–	–	–	–	–	X	–	–	–	–	–	
J. textilis	0	–	X	–	X	–	X	X	–	–	–	–	
LILIACEAE													
Calochortus spp.	4	X	–	–	–	–	–	–	–	–	–	–	22
Chlorogalum pomeridianum	4	X	–	X	–	–	X	X	–	X	–	tanning	1, 14, 18, 22, 49
Zigadenus fremontii	0	–	X	–	–	–	–	–	–	–	–	poison	22

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	MEDICINE hyg.	MATERIAL CULTURE clo.	MATERIAL CULTURE con.	MATERIAL CULTURE cra.	MATERIAL CULTURE tools	CEREMONIAL rel.	CEREMONIAL mag.	CEREMONIAL amu.	MISC USES	REFERENCES
AMARYLLIDACEAE													
Allium spp.	0	X	—	—	—	—	—	—	—	—	—	—	13, 22
Dichelostemma pulchellum	5	X	—	—	—	—	—	—	—	—	—	—	10, 13, 22, 27, 32
AGAVACEAE													
Yucca whipplei	1	X	—	—	X	—	X	X	—	—	—	fuel, tattoos	2, 9, 12, 20, 22, 25, 26, 31, 40
SAURURACEAE													
Anemopsis californica	0	—	X	—	—	—	—	—	—	—	—	—	5, 8, 18, 22, 47, 49
SALICACEAE													
Populus fremontii	1	—	X	—	X	X	X	—	—	—	—	fuel	3, 10, 22, 32, 33
P. trichocarpa	1	—	X	—	X	X	X	—	—	—	—	fuel	
Salix laevigata	1	—	X	X	X	X	X	X	X	—	X	fuel, tanning	
S. lasiolepis	3	—	X	X	X	X	X	X	X	—	X	fuel, tanning	2, 3, 8, 9, 15, 22, 25, 31, 32, 33

APPENDIX 1. *Plants Used by the Chumash (continued)*

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	MEDICINE hyg.	MATERIAL CULTURE clo.	MATERIAL CULTURE con.	MATERIAL CULTURE cra.	MATERIAL CULTURE tools	CEREMONIAL rel.	CEREMONIAL mag.	CEREMONIAL amu.	MISC. USES	REFERENCES
JUGLANDACEAE													
Juglans californica	0	X	–	–	–	–	X	–	–	–	X	–	3, 9, 16, 21, 22
BETULACEAE													
Alnus rhombifolia	2	–	–	–	–	–	X	–	–	–	–	dyeing	22, 31, 40
FAGACEAE													
Quercus agrifolia	3	X	X	X	X	–	X	X	X	–	X	fuel, dye, bait	2, 5, 9, 13, 14, 16, 18, 19, 22, 27, 31, 32, 38, 46, 47 49
Q. dumosa dumosa	1	X	–	–	–	–	X	X	–	–	–	–	
Q. dumosa kinselae	1	X	–	–	–	–	X	–	–	–	–	–	
Q. lobata	3	X	–	–	–	–	X	–	–	–	–	–	
URTICACEAE													
Urtica holosericea	0	–	X	–	X	X	X	–	–	–	–	–	2, 19, 22, 31
VISCACEAE (LORANTHACEAE)													
Phoradendron spp.	0	–	X	–	–	–	–	–	–	–	–	–	3, 22

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEMEMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
POLYGONACEAE													
Eriogonum elongatum	2	–	X	–	–	–	–	–	–	–	–	–	5, 8, 9, 18, 22, 49
E. fasciculatum	2	–	X	–	–	–	–	–	–	–	–	–	
Rumex crispus (I)	3	–	X	–	–	–	–	–	–	–	–	–	2, 8, 22
R. hymenosepalus	0	X	X	–	–	–	–	–	–	–	–	–	22
CHENOPODIACEAE													
Atriplex lentiformis subsp. *breweri*	1	–	X	–	–	–	–	–	–	–	–	(mission: soap-making)	3, 8, 22, 43, 48
Chenopodium ambrosioides (I)	1	X	–	–	–	–	–	–	–	–	–	–	22
C. berlandieri	1	X	–	–	–	–	–	–	–	–	–	–	22
C. californicum	2	–	X	X	–	–	–	–	–	–	–	–	22
AIZOACEAE													
Carpobrotus aequilaterus	0	X	–	–	–	–	–	–	–	–	–	–	22

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	MEDICINE hyg.	MATERIAL CULTURE clo.	MATERIAL CULTURE con.	MATERIAL CULTURE cra.	MATERIAL CULTURE tools	CEREMONIAL rel.	CEREMONIAL mag.	CEREMONIAL amu.	MISC. USES	REFERENCES
PORTULACACEAE													
Calandrinia ciliata	0	X	—	—	—	—	—	—	X	X	—	—	1, 10, 22, 23, 40, 41, 45
Montia perfoliata	1	X	—	—	—	—	—	—	—	—	—	—	22
PAEONIACEAE													
Paeonia californica	2	—	X	—	—	—	—	—	—	—	—	—	5, 8, 22
RANUNCULACEAE													
Clematis lasiantha	5	—	X	—	—	—	—	—	—	—	—	—	3, 8, 22
C. ligusticifolia	1	—	X	—	—	—	—	—	—	—	—	—	
LAURACEAE													
Umbellularia californica	5	—	X	—	—	—	X	—	—	X	—	—	8, 14, 22, 30, 49
PAPAVERACEAE													
Eschscholzia californica	2	—	X	—	—	—	—	—	—	—	—	—	10, 22
BRASSICACEAE													
Brassica spp. (I)	0	X	—	—	—	—	—	—	—	—	—	—	22, 35

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
Lepidium nitidum	1	X	X	—	—	—	—	—	—	—	—	—	8, 22
Rorippa nasturtium-aquaticum (I?)	0	X	X	—	—	—	—	—	—	—	—	—	8, 18, 22, 49
SAXIFRAGACEAE													
Ribes amarum	2	X	—	—	—	—	—	—	—	—	—	—	9, 22, 43
R. speciosum	2	X	—	—	—	—	—	—	—	—	—	—	
PLATANACEAE													
Platanus racemosa	4	—	—	—	—	—	X	—	—	—	—	—	3, 22, 43
ROSACEAE													
Adenostoma fasciculatum	5	—	X	—	—	—	—	X	—	—	—	—	22, 31
A. sparsifolium	0	—	X	—	—	—	—	—	—	—	—	—	5, 8, 18, 19, 22, 49
Cercocarpus betuloides	0	—	—	—	—	—	—	X	—	—	—	—	16, 22, 27, 31, 33, 35
Heteromeles arbutifolia	4	X	—	—	X	—	X	X	X	—	X	fuel	2, 9, 13, 22, 26, 31, 32

APPENDIX 1. *Plants Used by the Chumash (continued)*

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	hyg.	MATERIAL CULTURE clo.	con.	cra.	tools	CEREMONIAL rel.	mag.	amu.	MISC. USES	REFERENCES
Horkelia cuneata	2	—	X	—	—	—	—	—	—	—	—	—	5, 8, 18,
Potentilla glandulosa	6	—	X	—	—	—	—	—	—	—	—	—	22, 49
Prunus ilicifolia	6	X	—	—	—	—	—	—	X	—	—	—	3, 5, 10, 11, 13, 18, 19, 21, 22, 32, 33, 40, 42, 49
Rosa californica	3	X	X	—	X	—	—	—	—	—	—	—	8, 18, 22, 26, 49
Rubus ursinus	3	X	—	—	—	—	—	—	—	—	—	—	5, 13, 22
FABACEAE													
Lupinus sp.	1	X	—	—	—	—	—	—	—	—	—	—	16, 22
L. truncatus	1	X	—	—	—	—	—	—	—	—	—	—	22
Trifolium spp.	2	X	—	—	—	—	—	—	—	—	—	—	2, 22
GERANIACEAE													
Erodium moschatum (I)	1	X	X	—	—	—	—	—	—	—	—	fodder	5, 9, 18, 22, 34, 35, 49

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	MEDICINE hyg.	MATERIAL CULTURE clo.	MATERIAL CULTURE con.	MATERIAL CULTURE cra.	MATERIAL CULTURE tools	CEREMONIAL rel.	CEREMONIAL mag.	CEREMONIAL amu.	MISC. USES	REFERENCES
EUPHORBIACEAE													
Croton californicus	2	—	X	—	—	—	—	—	—	—	—	—	8, 22
Euphorbia sp.	0	—	X	—	—	—	—	—	—	—	—	—	5, 8, 41
ANACARDIACEAE													
Rhus integrifolia	3	X	X	—	—	—	—	—	—	—	—	—	
R. laurina	3	X	X	—	—	—	—	—	—	—	—	—	22, 40
R. ovata	3	X	X	—	—	—	—	—	—	—	—	—	
R. trilobata	1	X	—	—	—	—	X	—	X	—	—	—	9, 16, 17, 22, 31
Toxicodendron diversilobum	0	—	X	—	—	—	—	—	—	—	—	—	2, 19, 22, 47, 49
RHAMNACEAE													
Ceanothus megacarpus	6	—	—	—	—	—	—	X	X	—	—	(Moth coc-	2, 3, 9,
C. oliganthus	1	—	—	—	—	—	—	X	X	—	—	coons:	22, 31, 35
C. spinosus	7	—	—	—	—	—	—	X	X	—	—	rattles)	
Rhamnus californica	3	—	X	—		—							5, 8, 18, 22

APPENDIX 1. *Plants Used by the Chumash (continued)*

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	hyg.	MATERIAL CULTURE clo.	con.	cra.	tools	CEREMONIAL rel.	mag.	amu.	MISC. USES	REFERENCES
VITACEAE													
Vitis girdiana	0	X	–	–	–	–	–	–	–	–	–	–	2, 22, 32
MALVACEAE													
Malacothamnus fasciculatus	2	–	X	–	–	–	X	–	–	–	–	–	22
Malva parviflora (I)	1	X	X	–	–	–	X	–	–	–	–	–	5, 8, 14, 18, 22, 49
CACTACEAE													
Opuntia ficus-indica (I)	0	X	X	–	X	X	–	X	–	–	–	bait, paint	5, 9, 13, 14, 22, 25, 31, 32, 39, 40, 43, 48, 49
O. littoralis	0	X	X	–	–	–	–	X	–	–	–	ear-piercing	
O. oricola	0	X	–	–	–	X	–	–	–	–	–	–	
O. phaecantha	0	X	X	–	–	–	–	X	–	–	–	tattooing	
ONAGRACEAE													
Zauschneria californica	2	–	X	–	–	–	–	–	–	–	–	–	8, 35

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	MEDICINE hyg.	MATERIAL CULTURE clo.	MATERIAL CULTURE con.	MATERIAL CULTURE cra.	MATERIAL CULTURE tools	CEREMONIAL rel.	CEREMONIAL mag.	CEREMONIAL amu.	MISC. USES	REFERENCES
ARALIACEAE													
Aralia californica	0	—	X	—	—	—	—	—	—	—	—	—	8, 18
APIACEAE													
Apium graveolens (I)	0	X	—	—	—	—	—	—	—	—	—	—	22, 49
Foeniculum vulgare (I)	1	—	X	—	—	—	—	—	—	—	—	—	19, 49
Daucus pusillus	0	—	X	—	—	—	—	—	—	X	—	—	5, 22, 35, 43, 47
Lomatium californicum	0	X	X	—	—	—	—	—	—	X	—	—	5, 8, 18, 19, 22, 32, 35, 37, 42, 47
CORNACEAE													
Cornus stolonifera	0	—	—	—	—	X	X	X	—	—	X	—	22, 32, 33, 43
ERICACEAE													
Arctostaphylos glauca	5	X	X	—	—	—	—	—	—	—	—	—	2, 5, 16, 22, 49
PRIMULACEAE													
Anagallis arvensis (I)	7	—	X	—									14, 18, 49

APPENDIX 1. *Plants Used by the Chumash (continued)*

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
OLEACEAE													
Fraxinus dipetala	0	—	X	—	—	—	X	—	—	—	—	paint	19, 22
GENTIANACEAE													
Centaurium venustum	0	—	X	—	—	—	—	—	—	—	—	—	8, 22
APOCYNACEAE													
Apocynum cannabinum	0	—	—	—	X	X	X	X	X	—	X	—	2, 9, 22, 27, 31, 33
ASCLEPIADACEAE													
Asclepias eriocarpa	0	—	—	—	—	—	X	—	—	—	—	gum	1, 2,
A. fascicularis	0	—	—	—	—	—	X	—	—	—	—	gum	22, 31, 43
HYDROPHYLLACEAE													
Eriodictyon crassifolium	3	—	X	—	—	—	—	—	—	X	—	—	3, 5, 8, 9, 18, 22, 31, 47
VERBENACEAE													
Verbena lasiostachys	5	—	X	X	—	—	—	—	—	—	—	—	22
LAMIACEAE													
Marrubium vulgare (I)	2	—	X	—	—	—	—	—	—	—	—	—	18, 22, 49

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
Salvia apiana	2	—	X	—	—	—	—	—	X	X	—	—	1, 2, 5, 7, 8, 9, 16, 18, 22, 27, 29, 31, 32, 34, 36, 37, 40, 41, 42, 49, 50
S. columbariae	0	X	X	—	—	—	—	—	X	—	—	—	
S. leucophylla	4	X	X	—	—	—	—	—	X	X	—	—	
S. mellifera	4	X	X	—	—	—	—	—	X	X	—	—	
S. spathacea	4	X	X	—	—	—	—	—	—	—	—	—	
Satureja douglasii	0	X	X	—	—	—	—	—	—	—	—	—	5, 8, 18, 22, 47, 49
Trichostema lanatum	4	—	X	—	—	—	—	—	—	—	—	—	5, 22, 49
SOLANACEAE													
Datura meteloides[b]	1	—	X	—	—	—	—	—	X	—	—	—	4, 18, 19, 22, 27, 36, 47, 49
Nicotiana attenuata	0	—	X	—	—	—	—	—	X	X	X	—	2, 9, 10, 13, 18, 19, 22, 27, 31, 36, 40, 43, 47,
N. bigelovii	0	—	X	—	—	—	—	—	X	X	X	—	
N. Clevelandii	0	—	X	—	—	—	—	—	X	X	X	—	
Solanum douglasii	3	X	X	X	—	—	—	—	—	—	—	tattooing	22, 31

APPENDIX 1. Plants Used in the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	hyg.	MATERIAL CULTURE clo.	con.	cra.	tools	CEREMONIAL rel.	mag.	amu.	MISC. USES	REFERENCES
SCROPHULARIACEAE													
Keckiella cordifolia	5	–	X	–	–	–	–	–	–	–	–	–	5, 8, 22
PLANTAGINACEAE													
Plantago lanceolata (I)	0	–	X	–	–	–	–	–	–	–	–	–	8, 18, 22
CAPRIFOLIACEAE													
Lonicera johnstonii	2	–	–	–	–	–	X	X	–	–	–	–	
L. subspicata	4	–	X	–	–	–	–	–	–	–	–	–	3, 5, 8, 22, 34
Sambucus mexicana	7	X	X	–	–	–	X	X	X	X	X	–	5, 8, 9, 18, 19, 21, 22, 31, 49
Symphoricarpos mollis	3	–	–	–	–	–	X	X	–	–	–	–	22, 31
CUCURBITACEAE													
Cucurbita foetidissima	0	–	X	X	–	–	X	–	–	X	X	–	3, 5, 16, 22, 27, 31, 34
Marah macrocarpus	1	–	X	X	X	–	–	–	–	X	X	–	5, 14, 19, 22, 37, 47
ASTERACEAE													
Achillea millefolium	3	–	X	–	–	–	–	–	–	–	–	–	8, 22

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE cur.	hyg.	MATERIAL CULTURE clo.	con.	cra.	tools	CEREMONIAL rel.	mag.	amu.	MISC. USES	REFERENCES
Artemisia californica	2	—	X	—	—	X	—	X	X	X	X	—	8, 18, 22, 31
A. douglasiana	3	—	X	—	—	—	—	—	—	—	—	cradle lining	1, 5, 8, 9, 10, 14, 18, 22, 47, 49
A. tridentata	2	—	—	—	—	—	—	X	—	—	—	fuel	22
Baccharis glutinosa	1	—	—	—	—	—	—	X	—	—	—	—	9, 22
B. pilularis	3	—	X	—	—	—	—	—	—	—	—	—	18
B. plummerae	3	—	X	—	—	—	—	—	—	—	—	—	5, 8, 18, 19, 22, 49
Gnaphalium bicolor	1	—	X	—	—	—	—	—	—	—	—	—	
G. californicum	4	—	X	—	—	—	—	—	—	—	—	—	5, 8, 20, 22
G. microcephalum	1	—	X	—	—	—	—	—	—	—	—	—	
Grindelia sp.	0	—	X	—	—	—	—	—	—	—	—	—	5, 8, 41, 43
Helenium puberulum	1	—	X	—	—	—	—	—	—	—	—	—	8, 22, 43
Hemizonia ramosissima	3	X	—	—	—	—	X	—	—	—	—	—	6, 16, 22, 43
Heterotheca grandifolia	1	—	—	X	—	—	—	—	—	—	—	—	22
Layia platyglossa	0	X	—	—	—	—	—	—	—	—	—	—	22

APPENDIX 1. Plants Used by the Chumash (continued)

Plant species	Spec. at NAA	FOOD	MEDICINE		MATERIAL CULTURE				CEREMONIAL			MISC. USES	REFERENCES
			cur.	hyg.	clo.	con.	cra.	tools	rel.	mag.	amu.		
Matricaria matricarioides	1	–	X	–	–	–	–	–	–	–	–	–	5, 8, 18, 21, 22, 49
Perezia microcephala	2	–	X	–	–	–	–	–	–	–	–	–	5, 8, 18, 22, 43
Solidago californica	3	–	X	–	–	–	–	–	–	–	–	–	5, 8, 18, 22, 43
Sonchus oleraceus (I)	3	X	–	–	–	–	–	–	–	–	–	–	22
Xanthium strumarium	1	–	X	–	–	–	–	–	–	–	–	–	8, 18, 22

ABBREVIATIONS USED:

Spec. at NAA = Plant specimens in the Harrisonton collection at the National Anthropological Archives, Smithsonian Institution

cur. = curing	clo. - clothing	rel. = religious	(I) = Introduced species	numbered references are listed at the beginning of the Appendix
hyg. = hygiene	con. = construction	mag. = magical	X = recorded usage	
	cra. = crafts	amu. = amusements	– = no recorded usage	

[a]*Sequoia sempervirens* driftwood was utilized; this plant does not grow in Chumash territory.

[b]*Datura meteloides*, despite its acceptance in standard reference works, is an invalid taxon which is undergoing revision (Robert A. Bye, personal communication 1984).

Book Review

Usos de los Helechos en Suramerica con Especial Referencia a Colombia (Uses of ferns in South America with special reference to Colombia). Maria Teresa Murillo. Bogota: Universidad Nacional de Colombia, 1983. 156 pp., illustrated, (no price listed).

This book is a compendium of the ethnobotany of South American (primarily Colombian) ferns, written at the suggestion of Dr. Richard E. Schultes and published in connection with the bicentennial of the Royal Botanical Expedition of 1783. It represents a remarkably thorough review of the relevant literature, and an extensive survey of the National Herbarium in Bogota, where the author is located.

The book is divided into two primary sections. The first includes a key to the orders and families of Colombian ferns, accompanied by formal botanical descriptions of each family and line drawings of representative taxa. The second part lists nearly 130 species of ferns, horsetails, and lycopods utilized by the peoples of South America, along with a botanical description of each, their vernacular names in various regions, the approximate distribution of each within Colombia, and a series of quotations describing in detail how each plant is used. This section is accompanied by 12 full-page, color plates illustrating several of the species.

Unfortunately, the two sections of the book are not very well coordinated. Despite the presence of the familial keys, there is no key to species, nor even any indication of which species is in which family, making it nearly impossible to use the book as a field guide. Nevertheless, there is much information of interest not only to students of South American ethnobotany but also to ethnopteridologists of other continents as well.

The entire book is in Spanish.

Joseph E. Laferriere
Department of Ecology &
Evolutionary Biology
University of Arizona
Tucson, Arizona

J. Ethnobiol. 4(2):171-176 December 1984

CONTRIBUTIONS OF FRANK G. SPECK (1881-1950) TO ETHNOBIOLOGY

RALPH W. DEXTER
Department of Biological Sciences
Kent State University
Kent, Ohio 44242

ABSTRACT.–F.G. Speck, a naturalist-ethnographer, was a specialist on the Indians of Eastern North America. Forty eight studies (about 1/5 of his publications, including three books) were devoted to ethnobiology exclusively or as a primary concern and many other papers included such information incidentally. Major studies involved the Beothuk and Micmac of Eastern Canada, the Naskapi of Labrador, and the Penobscot of Maine. He studied material culture, resource utilization and preservation, methods of hunting, trapping, fishing, etc., family hunting territories, food, medicinal uses, and animal folklore among such Indian groups as the Algonkian, Huron, Six Nations, Wampanoag, Delaware, Rappahannock, Catawba, Houma, etc. and the Eskimo of southern Labrador. His major contribution was the detailed study of family hunting territories and their ecological importance in the economy of these native peoples. Originally he believed such a system was pre-Columbian, but later was convinced that the practice probably developed after contact with Europeans and their demands for the fur trade coupled with game cycles and periodic game scarcity.

INTRODUCTION

In his essay on the history and scope of ethnobiology, Castetter (1944) pointed out that the science of ethnobiology is more than the study of utilization of renewable resources and is equally concerned with the total biological environment and interactions between man and plant and animals. Frank G. Speck (1881-1950), trained by Franz Boas, was an American ethnologist who gave much attention to studies in ethnobiology. Biographical accounts of Speck have been published by Wallace (1949), Mason (1950), Witthoft (1950), Hallowell (1951), and Dexter (1954). As a specialist on the Eastern Indians of North America, Speck published 247 papers in that field (1903-1952), 48 of which involved some phase of ethnobiology in which plants and animals are a major concern and many others in which they are mentioned incidentally. We might say Speck was a "naturalist-ethnographer," since in addition to his works on ethnology he published 15 articles on natural history (1898-1946). These were mostly on herptiles and birds for which he had a life-long interest. Originally he had planned to become a naturalist. As a young man he worked with and become a protege of the famous herpetologist Raymond L. Ditmars, and vertebrates played a prominant part in his later studies on ethnobiology. Wallace (1951) gave a good review of Speck and his field methods.

MAJOR ETHNOGRAPHICAL WORKS

Speck published three books of comprehensive scope which contain extensive notes on ethnobiology. The first was *Beothuk and Micmac* (1922). He included a section on hunting territories in Nova Scotia, Cape Breton Island, and Prince Edward Island established by the Micmac-Montagnais of Newfoundland. His second and third books were devoted to the Naskapi hunters of Labrador (1935a) and Penobscot Man of Maine (1940a). These, too, were much concerned with methods of hunting and utilization of natural resources.

MATERIAL CULTURE AND UTILIZATION STUDIES

One of Speck's earliest and most persistent investigations concerned utilization of plants and animals. (Dates without names refer to Speck.) Birch-bark (1910, 1928a,

1931) for many uses such as canoes, house coverings, cooking vessels, dishes, and baskets was naturally included, but he pointed out that contrary to common belief it was not used to shape pottery. Other utilizations included feathers and moose hair for decorating clothing and moccasins, and deer, moose, and caribou skin for making moccasins and coats. Utensils of many types and wampum belts were made from plants and animals by the Huron of Quebec (1911a, 1911b). He published special reports on the use of wampum for ornamentation, as a medium of exchange, and eventually for ceremonial purposes by the Eastern Algonkians (1916, 1919). Two very special wampum belts given to William Penn by the Delawares and the Six Nations during negotiations for land were described by Speck and Orchard (1925). He reported on, with artistic explanation, the feather art and hair ornaments of the Sioux in South Dakota (1928b). Sealskin preparation in Labrador was included among other topics for studies on Eskimos and Indians in southern Labrador (1935-1936). He described the use of ivory and bone for art, ornaments, and implements for the Eskimo of northern Labrador and Newfoundland (1927a, 1940b) and in eastern Pennsylvania (1930).

Speck made a special study of gourds and their utilization by Southeastern Indians of the United States (1941a, 1941b, 1948-49). These inventive peoples found uses for gourds as rattles, drums, musical instruments, containers, lamp stands, candle holders, emblems, implements, dippers, cups, toys, games, and medicines. He listed 35 traits and functions served by gourds for 13 different tribes of the Southeast.

STUDIES ON FOOD

Speck and Dexter (1946, 1948, 1951, 1952) published a series of reports based primarily on wild plants and animals utilized as food along with several incidental uses of some of the food organisms. They included uses of marine mollusks by the Houma Indians of Louisiana, utilization of marine life by the Wampanoag Indians of coastal Massachusetts, and of biological resources by the Micmac and the Malecite Indians (also called Etchemins) of New Brunswick, Canada. In addition to food, some plants and animals were important to these peoples as bait, ornaments, beads (wampum), implements, utensils, games and medicines.

RESOURCE PRESERVATION AND HUNTING TERRITORIES; HUNTING ACTIVITIES

As a naturalist, as well as an ethnographer, Speck was much interested in game preservation, hunting territories, and conservation measures in general. Many studies were devoted to these topics, and they became his major contribution to ethnobiology. Some early papers were devoted to general matters of conservation. He pointed out that Indians were the "best protectors of the game" and that " . . . the increase *only* is consumed" (1913). Although this has not proved to be universal, it has been true more often than not. In a paper published for students of birds (1938a), he pointed out the Indian's "understanding of the need of sustaining the balance of nature," and consequently the numerous regulations developed for taking plants and animals. Vecsey and Venables (1980) have pointed out that "as much as anyone, Speck fostered the idea of Indians as lovers and conservers of nature."

Many of Speck's papers were devoted to family hunting territory. These studies detailed the hunting systems of many bands of the Algonkian groups such as the Micmac, Timiskaming, Dumoine River, and Kipawa (1915a, 1915b), also, the Timagami band of Ojibwa in northern Ontario, and the Mistassini of Labrador (1923a). Later studies were involved with the Wabanaki, Malecite, the Lake St. John Montagnais, and neighboring bands of New Brunswick, the Hurons of Lorette in Quebec, and the Wampanoag, Massachusett, and Nauset Indians of Massachusetts (1926, 1927b, 1927c, 1928c, Speck and Hadlock, 1946) and the Labrador Eskimo and Indians (1936, Speck and Eiseley, 1942).

In a review paper by Speck and Eiseley (1939), the authors defended the system of family hunting territories as being pre-Columbian, but, after a thorough study of the matter, Leacock (1954) concluded that family hunting territory came after settlement by Europeans. Hickerson (1967:313-314) pointed out that "Speck concluded that family or individual rights to land characterized aboriginal, even ancient property relations. . . . Speck's hypothesis proved to be the cornerstone of a general theory of the particularity, or 'atomism' of Algonkian collectors." But Hickerson continued, "In opposition to the idea that the family hunting territory system was aboriginal among northern Algonkians, Jenness asserted in 1932 that the Athabascam Sekani had developed their family property system in historical times, following the practice of the White trappers." Hickerson agreed with Jenness. Wallace also reviewed Speck's theory and concluded that, "Speck—simply assumed that such a system of ownership and planned exploitation was reasonable, considering the nature of the game and the physical contact with European traders. He was challenged on this assumption very frequently" (Wallace 1968:22). These writers, however, were unaware that Speck had already changed his mind. In a letter Speck wrote to Julian H. Steward, dated 22 January 1940, he admitted that family hunting territories were not "archaic" nor "pre-Columbian", but probably developed as an ecological consequence after contact with Hudson Bay Co. fur buyers, and experience with game cycles and the scarcity of game.[1] While Speck's *theory* on the origin of family hunting territories was incorrect, his detailed studies of the practice in historic times are a major contribution to ethnobiology.

Several studies were devoted to methods of taking game and fish. He described the use of dogs by the Montagnais and Naskapi (1925), and their methods of skindressing for the major mammal and bird skins taken in Labrador compared with the Eskimo of coastal Labrador (1937a). The use of blow guns by the Catawba in the southeastern U.S. is given as well as method of hunting and fishing with a seasonal chart (1938b, 1946a). Hunting and trapping techniques for mammals, and fishing methods for seafoods by the Houma Indians of Lousiana (1943), and for the Rappahannock of Virginia (Speck, Hassrick and Carpenter, 1946) are described in detail. Rabbit drives by the Nanticoke of Delaware, Catawba of South Carolina, Pamunkey, Powhatan, and Rappahannock of Virginia are also described (1946b, Speck and Schaeffer, 1950). Eel pots and their construction by the Nanticokes were studied in detail (1949).

NATIVE MEDICINE: HERBALS

Medicinal uses have been one of the major concerns of ethnobiologists. While Speck was more concerned with ecological aspects of natural resources, their acquisition, and family hunting territory systems than in medical practice, he did include that aspect in certain cases. In his study of the Algonkians he recorded utilization of plants for medical purposes by the Penobscot, Montagnais, Micmac, Mohegan, and Nanticoke groups (1917). In his study of the Catawba of the Carolinas he described the gathering, preparation, and administration of medicines for 14 different illnesses. Roots and leaves of certain herbs were used for cures, as well as a few animal parts, especially from snakes and turtles (1937b, 1944). Merrell (1983) has recently given an excellent appraisal of Speck's work, published and unpublished, among the Catawba. He wrote, "Speck collected almost 100 curative items that could cope with everything from backache and boils to warts and worms," and concluded that the "Catawbas derived most of these remedies from local plants, demonstrating once again that ancient, intimate knowledge of the natural world" (Merrell 1983:252).

In his study of the Houma Indians of Louisiana he compiled an annotated list of 73 species of plants and their medicinal uses (1941c), and did much the same for the Rappahannock of Virginia (Speck, Hassrick and Carpenter, 1942). His last study in that direction concerned an Indian Medicine-man named Joe Pye in eastern Massachusetts who cured fever with an herb now commonly called Joe Pye Weed (Speck and Dodge, 1945a).

ETHNOHERBETOLOGY: ETHNOORNITHOLOGY

Reptiles and birds, as noted earlier, held a special fascination for Dr. Speck, and he combined this interest in natural history with his studies in ethnography. A special paper on bird-lore was devoted to such studies among the Penobscot, Malecite, Micmac, and the Abenaki. He learned that about one-third of the names of birds were derived from their utterances, while the remainder were derived from descriptions of the bird (1921). A similar study on reptile-lore among these northern Indians, and including the Naskapi, was published two years later (1923c) and a general paper on the knowledge of amphibians and reptiles by the Cayuga of Ontario was published by Speck and Dodge (1945b). He gave special attention to the native and colloquial English names for snakes, turtles, lizards, frogs, and toads, and fables concerning them, in the culture of the Catawba and Cherokee of Piedmont, North Carolina (1946c). For the Delawares in Ontario he gave the names of birds in both native language and colloquial English equivalent (along with official Latin and English names), and gave the Indian's interpretation of the calls and songs of those birds (1946d). In his final paper on this topic he described the Indian's interpretation of metamorphosis of geese into beavers, of snakes into raccoons, of deer into whales, etc. (Speck and Wittoft, 1947).

CONCLUSIONS

Frank G. Speck, naturalist-ethnographer, made numerous contributions to the ethnobiology of American Indians of eastern North America. He worked with many ethnic groups over many years reporting on their preservation and utilization of natural resources for clothing, decoration, utensils, foods, and medicines, and their methods employed in obtaining those resources. Also, he studied and reported on the role of animal life in their folklore.

He gave much attention to the family hunting territory system which he at first believed to be pre-Columbian in origin, but later was convinced that the system developed after contact with Europeans and their demand for furs. In spite of his initial conclusion, his studies explain the operation of the system in historic time for several different groups.

In some 48 publications, including three books, ethnobiology was a major if not exclusive focus, and it was incidentally included in many other works.

LITERATURE CITED

CASTETTER, EDWARD F. 1944. The domain of ethnobiology. Amer. Nat. 78:158-170.

DEXTER, RALPH W. 1954. On field trips with Frank G. Speck, American ethnologist. The Biologist 36:13-17.

HALLOWELL, A. IRVING. 1951. Frank Gouldsmith Speck, 1881-1950. Amer. Anthrop. 53:67-87.

HICKERSON, HAROLD. 1967. Some implications of the theory of the particularity, or "atomism", of Northern Algonkians. Current Anthrop. 8:313-343.

JENNESS, DIAMOND. 1958. The Indians of Canada. Bull. 65, Anthrop. Ser. No. 15, Nat. Mus. Canada. Ottawa, Canada.

LEACOCK, ELEANOR B. 1954. The Montagnais "hunting territory" and the fur trade. Amer. Anthrop. 56(5, pt. 2):1-59.

MASON, J. A. 1950. Frank Gouldsmith Speck. 1881-1950. Bull. Philadelphia Anthrop. Soc. 3:3-4.

MERRELL, JAMES H. 1983. Reading "An almost erased page": A reassessment of Frank G. Speck's Catawba studies. Proceed. Amer. Philos. Soc. 127:248-262.

SPECK, FRANK G. 1910. Some uses of birds

LITERATURE CITED (continued)

bark by our Eastern Indians. Mus. Jour., Univ. Pennsylvania 1:33-36.

__________. 1911a. Notes of the material culture of the Huron. Amer. Anthrop. 13: 208-228.

__________. 1911b. Huron moose hair embroidery. Amer. Anthrop. 13:1-14.

__________. 1913. The Indians and game preservation. The Red Man 6:21-25.

__________. 1915a. The family hunting band as the basis of Algonkian local organization. Amer. Anthrop. 17:289-305.

__________. 1915b. Family hunting territories and social life of various Algonkian bands of the Ottawa Valley. Canada Dept. Mines, Geol. Survey Mem. No. 70 (Anthrop. Series No. 8).

__________. 1916. Wampum in Indian tradition and currency. Proceed. Numismatic and Antiquarian Soc. of Philadelphia 27: 121-130.

__________. 1917. Medicine practices of the Northeastern Algonquians. Proceed. 19th Internat. Cong. Americanists, pp. 303-321.

__________. 1919. The functions of wampum among the Eastern Algonkian. Mem. Amer. Anthrop. Assoc. 6:3-71.

__________. 1921. Bird lore of the Northern Indians. Univ. Pennsylvania Faculty Public Lectures 7:349-380.

__________. 1922. Beothuk and Micmac. Indian Notes and Monographs (Mus. Amer. Indian, Heye Founda.) Series 2, no. 22.

__________. 1932a. Mistassini hunting territories in the Labrador Peninsula. Amer. Anthrop. 25:452-471.

__________. 1923b. Reptile lore of the Northern Indians. J. Amer. Folk-lore 36: 273-280.

__________. 1923. Snake-folklore:the snake who swallows her young. J. Amer. Folklore 36:298-300.

__________. 1925. Dogs of the Labrador Indians. Nat. Hist. 25:58-64.

__________. 1926. Culture problems in Northeastern North America. Proceed. Amer. Philos. Soc. 65:272-311.

__________. 1927a. Eskimo carved ivories from Northern Labrador. Indian Notes (Mus. Amer. Indian, Heye Founda.) 4:309-314.

__________. 1927b. Family hunting territories of the Lake St. John Montagnais and neighboring bands. Anthropos 22:387-403.

__________. 1927c. Huron hunting territories in Quebec. Indian Notes (Mus. Amer. Indian, Heye Founda.) 4:1-12.

__________. 1928a. Mohegan beadwork on birch bark. Indian Notes (Mus. Amer. Indian, Heye Founda.) 5:295-298.

__________. 1928b. Notes of the functional basis of decoration and the feather technique of the Oglala Sioux. Indian Notes (Mus. Amer. Indian, Heye Founda.) 5:1-42.

__________. 1928c. Territorial subdivisions and boundaries of the Wampanoag, Massachusett, and Nauset Indians. Indian Notes and Monographs (Mus. Amer. Indian, Heye Founda.) No. 44, 152 pp.

__________. 1930. An ethnologist's impression of the bone implements from Safe Harbor. Bull. Soc. Pennsylvania Arch. 1: 4-6.

__________. 1931. Birch-bark in the ancestry of pottery forms. Anthropos 26:407-411.

__________. 1935. Naskapi–the savage hunters of the Labrador Peninsula. Univ. Oklahoma Press, Norman.

__________. 1935-36. Eskimo and Indian backgrounds in Southern Labrador. Gen. Mag. and Hist. Chronicle (Univ. Pennsylvania) 38:1-17; 143-163.

__________. 1936. Inland Eskimo bands of Labrador. Pp. 317-322. *in:* Lowie, R.H. (ed.). Essays in anthropology presented to A. L. Kroeber. Univ. California Press, Berkeley.

__________. 1937a. Analysis of Eskimo and Indian skin-dressing methods in Labrador. Ethnos 2:345-353.

__________. 1937b. Pp. 179-197. Catawba medicines and curative practices. Philadelphia Anthrop. Soc. (25th Anniver. Vol.).

__________. 1938a. Aboriginal conservators. Bird-lore 40:258-261.

__________. 1938b. The cane blowgun in Catawba and Southeastern Ethnology. Amer. Anthrop. 40:198-204.

__________. 1940a. Penobscot man, the life history of a forest tribe in Maine. Univ. Pennsylvania Press, Philadelphia.

__________. 1940b. Eskimo jacket ornaments of ivory suggesting function of bone pendants found in Beothuk sites in Newfoundland. Amer. Antiquity 5:225-228.

__________. 1941a. The gourd lamp among the Virginia Indians. Amer. Anthrop. 43: 676-678.

__________. 1941b. Gourds of the South-

LITERATURE CITED (continued)

eastern Indians. New England Gourd Soc., Boston.

__________ 1941c. A list of plant curatives obtained from the Houma Indians of Louisiana. Primitive Man 14:49-73.

__________. 1943. A social reconnaissance of the Creole Houma Indian trappers of the Louisiana Bayous. Amer. Indigena 3:134-146; 210-220.

__________. 1944. Catawba herbals and curative practices. J. Amer. Folk-lore 57:37-50.

__________. 1946a. Catawba hunting, trapping and fishing. Joint Publ., Mus. Univ. Pennsylvania and Philadelphia. Anthrop. Soc. No. 2.

__________. 1946b. Cudgelling rabbits and old Nanticoke hunting tradition and its significance. Bull. Arch. Soc. Delaware 4:9-12.

__________. 1946c. Ethnoherpetology of the Catawba and Cherokee Indians. J. Washington Acad. Sci. 36:355-360.

__________. 1946d. Bird nomenclature and song interpretation of the Canadian Delaware: an essay in ethno-ornithology. J. Washington Acad. Sci. 36:249-258.

__________. 1948-49. Addendum to gourds of the Southeastern Indians. Gourd Seed 9:15; 10:3-6, 8, 11-12, 16.

__________. 1949. A maker of ell pots among the Nanticokes of Delaware. Bull. Arch. Soc. Delaware 4:25-27.

SPECK, FRANK G. and RALPH W. DEXTER. 1946. Molluscan food items of the Houma Indians. Nautilus 60:34.

__________. 1948. Utilization of marine life by the Wampanoag Indians of Massachusetts. J. Washington Acad. Sci. 38:257-265.

__________. 1951. Utilization of animals and plants by the Micmac Indians of New Brunswick. J. Washington Acad. Sci. 41: 250-259.

__________. 1952. Utilization of animals and plants by the Malecite Indians of New Brunswick. J. Washington Acad. Sci. 42:1-7.

SPECK, FRANK G. and ERNEST S. DODGE. 1945a. On the fable of Joe Pye, Indian herbalist, and Joe Pye weed. Sci. Month. 61:63-66.

__________. 1945b. Amphibian and reptile lore of the Six Nations Cayuga. J. Amer. Folk-lore 58:306-309.

SPECK, FRANK G. and LOREN C. EISELEY. 1939. Significance of hunting territory systems of the Algonkian in social theory. Amer. Anthrop. 41:269-280.

__________. 1942. Montagnais–Naskapi bands and family hunting districts of the Central and Southeastern Labrador Peninsula. Proceed. Amer. Philos. Soc. 85:215-242.

SPECK, FRANK G. and W.S. HADLOCK. 1946. A report on tribal boundries and hunting areas of the Malecite Indian of New Brunswick. Amer. Anthrop. 48: 355-374.

SPECK, FRANK G., R.B. HASSRICK, and E.S. CARPENTER. 1942. Rappahannock herbals, folklore, and science of cures. Proceed. Delaware Co. Insti. Sci. 10:1-55.

__________. 1946. Rappahannock taking devices: traps, hunting and fishing. Joint Publ. Mus. Univ. Pennsylvania and Philadelphia. Anthrop. Soc. No. 1.

SPECK, FRANK G. and W.C. ORCHARD. 1925. The Penn wampum belts, Leaflets Mus. Amer. Indian (Heye Foundation). No. 4.

SPECK, FRANK G. and C.E. SCHAEFFER. 1950. The deer and rabbit hunting drive in Virginia and the Southeast. Southern Indian Studies 2:4-20.

SPECK, FRANK G. and JOHN WITTHOFT. 1947. Some notable life-histories in zoological folklore. J. Amer. Folk-lore 60:78-84.

VECSEY, CHRISTOPHER and ROBERT W. VENABLES. 1980. American Indian environments, ecological issues in native American history. Syracuse Univ. Press, Syracuse, New York.

WALLACE, ANTHONY F.C. 1949. In memoriam: Frank G. Speck. Pennsylvania Arch. 19:51-53.

__________. 1951. The Frank G. Speck collection. Proceed. Amer. Philos. Soc. 95:286-289.

__________. 1968. The value of the Speck papers for ethnohistory. Pp. 20-34 in: The American Indian: A conference in the American Philosophical Society Library. Amer. Philos. Soc. Lib. Publ. No. 2.

WITTHOFT, JOHN. 1950. Frank Gouldsmith Speck, 1881-1950, Ethnologist and Teacher. Southern Indian Studies 2:38-44.

NOTE

1. Quoted by permission: Archives, University of Illinois Library.

J. Ethnol. 4(2): 177-190 December 1984

PEELED PONDEROSA PINE TREES: A RECORD OF INNER BARK UTILIZATION BY NATIVE AMERICANS

THOMAS W. SWETNAM
Laboratory of Tree-Ring Research
University of Arizona
Tucson, Arizona 85721

ABSTRACT.–References by explorers, ethnologists and others to the utilization of pine *(Pinus* spp.) inner bark as a food indicate that some cultural groups of North American Indians may have used inner bark regularly, perhaps on an annual basis, while other groups may have used it primarily as an emergency food, such as during famine. The peeling dates and historical circumstances of one group of trees in the Gila Wilderness, New Mexico suggest that these trees were probably peeled by the Gila Apache when they were very hungry. Inventory of surviving peeled trees, and dendrochronological dating of the peeling scars may help answer remaining questions about the importance and utilization patterns of pine inner bark as a food source.

INTRODUCTION

Pine trees with large oval or rectangular scars on their trunks can be observed in many scattered locations in the western United States (Fig. 1). The physical appearance of these scars is different from scars created by fires or other disturbances (Table 1). These distinctive scars are attributable to the peeling of the outer bark by Native Americans to procure for food the soft, stringy layer of phloem and cambium cells that occur between the outer bark and the secondary xylem cells (wood) of the trunk (Martorano 1981; Newberry 1887; White 1954). This layer has been referred to as the "inner bark", and its utilization has been widely reported in the ethnographic literature, however, generally it has been mentioned only in passing.

The first part of this paper considers different utilization patterns of inner bark in a review and discussion of the ethnographic literature, with special emphasis on ponderosa pine *(Pinus ponderosa* Laws.) inner bark utilization in the southwestern United States. The second part discusses problems of sampling peeled trees for dendrochronological dating, and problems of interpreting estimated peeling dates. The third part reports the locations and peeling dates of three groups of peeled trees in New Mexico, and historic evidence concerning one of the groups. A summary includes comments on the potential importance and applications of peeled tree information for ethnographic studies.

INNER BARK UTILIZATION PATTERNS

There is extensive literature on the utilization of the outer bark and sap of many different species of trees for various technological, medical and ceremonial purposes by numerous groups of peoples throughout the world. This review and discussion is focused on the utilization of pine *(Pinus* spp.) inner bark for food.

The earliest original reference found was in the Lewis and Clark journals (Thwaites 1905). The use of pine inner bark was mentioned on two occasions in the journals, and the differences in these entries illustrate the difficulty of determining if there was a consistent usage pattern of inner bark. The first journal entry was by William Clark on September 12, 1805, while the party was in the Bitterroot Mountains of present-day Montana and consisted of one sentence:

> I mad(e) camp at 8 on this roade & particularly on this Creek the Indians have pealed a number of Pine for the under bark which they eate at certain Seasons of the year, I am told in the Spring they make use of this bark . . .

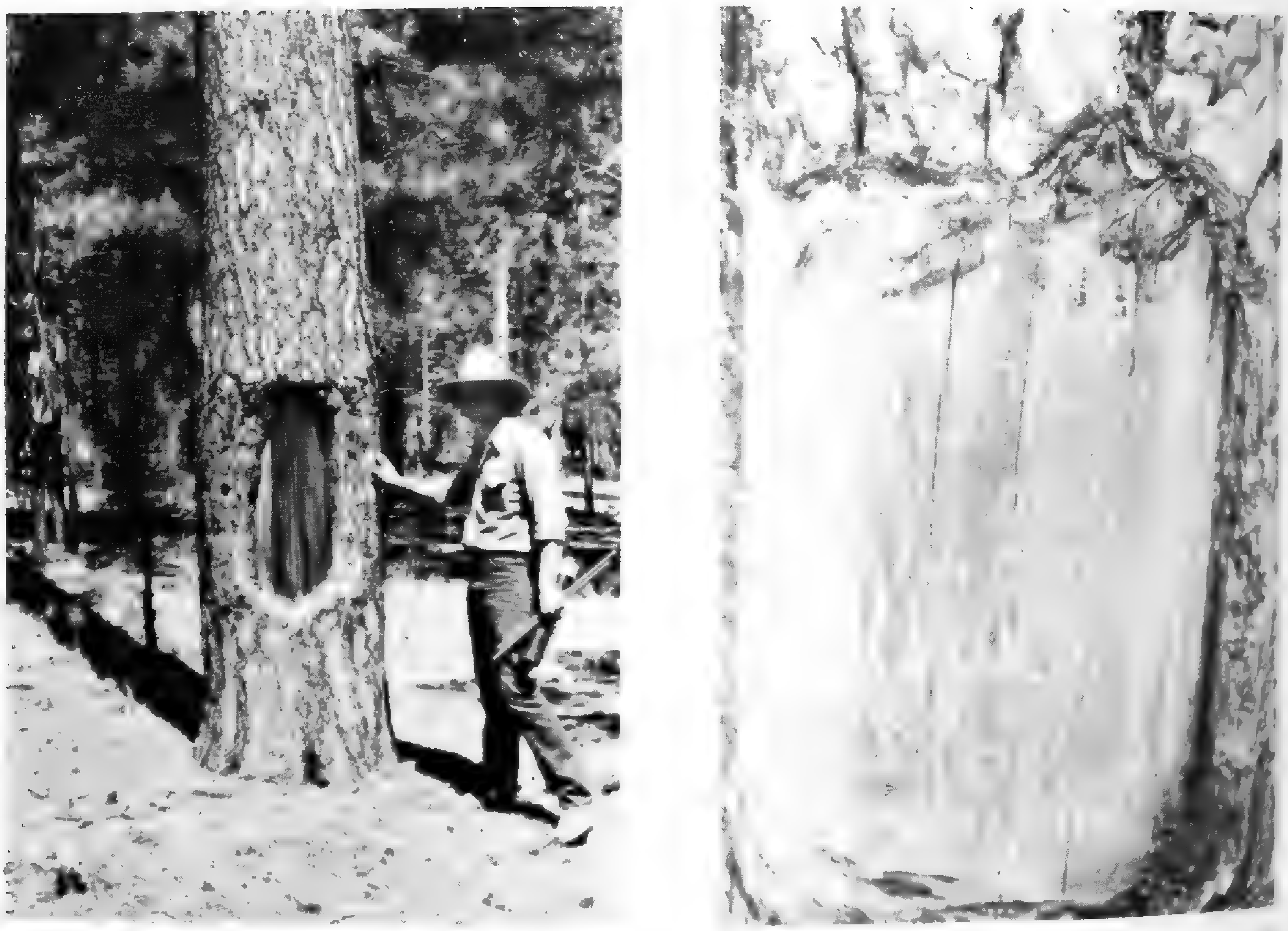


FIG. 1–Left, peeled tree in Lilley Park, Gila Wilderness New Mexico. Right, many peeling scars will show axe marks along the top and/or bottom of the wound.

Thus, the above sentence suggests that it was a seasonal or regularly used food. However, the second entry by Meriwether Lewis, on May 8, 1806, was in the context of a discussion of famine conditions during the previous winter when the Indians, possiby the Shoshoni, were reduced to boiling and eating the moss growing on pine trees. Although inner bark utilization was mentioned in the same paragraph as the famine discussion, it was not specifically referred to as food resorted to only during times of famine.

Other early references to inner bark utilization clearly indicate that it was an emergency food. For example, Sturtevant (1919:436) cites a paper presented by Brown to the Edinburgh Botanical Society in 1868:

> In times of scarcity, says R. Brown, the Indians will eat the liber [inner bark]. Along both sides of the trail in the passes of the Galton and Rocky Mountains, many of the young trees of this species [*Pinus contorta* Dougl.] are stripped of their bark for a height of six or seven feet.

And John Strong Newberry, a distinguished physician and naturalist of Columbia University, based the following description on observations while traveling with government survey expeditions in the far west in about 1859 (Newberry 1887:46):

> One article of subsistence sometimes employed by the Indians is only resorted to when they are driven to great straits by hunger. Around many of the watering-places in the pine forests of Oregon and California the trees of *Pinus ponderosa* may be seen stripped of their bark for a space of three or four feet near the base of the trunk. This has been accomplished by cutting with a hatchet a line around the tree as high us as one could conveniently reach, and another lower down, so that the bark, severed above and below, could be removed in strips. At certain seasons of the year a mucilaginous film (the liburnum) separates the bark from the wood of the trunk. Part of this film adheres to each surface and

TABLE 1.–*Characteristics of various types of scars observed on tree trunks.*

Scar Type (cause)	Approximate Location	Distinguishing Features
Inner Bark Peeling (human)	Bottom of scar usually above ground level. Top of scar sometimes up to 3 meters above ground.	Oval or rectangular shape, or sometimes pointed at top. Axe marks occasionally visible at bottom or top. Occur in groups, often near campsites with water.
Trail Blaze (human)	Breast height or slightly higher. (1.4 meters above ground).	Small stripe, spot or both. Usually on both sides of tree. Occur on trails or other travel routes.
Survey or Witness Tree (human)	Breast height. (1.4 meters above ground).	Round or rectangular shape with numbers or other information carved, stamped or posted. Usually a single tree.
Fire	Ground level up to any height.	Triangular shape or elongated strip, widest at bottom. Charred wood, and sometimes concave at bottom. Often occur on uphill side of tree on slopes.
Lightning	Anywhere on bole, sometimes extending from top of tree to bottom.	Usually a narrow strip, sometimes spirals around tree. Occur randomly.
Animal Gnawing	Usually on branches or stems of smaller trees, or near tops of larger trees.	Irregular shapes, teeth marks sometimes visible.
Scrape (falling trees, rock slides, etc.)	Anywhere on tree.	Irregular shapes. Occur randomly.

may be scraped off. The resulting mixture of mucilage cells and half-formed wood is nutritious and not unpalatable, so that, as a last resort, it may be used as a defense against starvation. The frequency with which signs of its having been resorted to are met with is a striking indication of the uncertainties and irregularities of the supply department among savages.

Several specific Southwestern references for use of pine inner bark by the Zuni (Castetter 1935:42; Cushing 1920:223; Standley 1912:448) and the Mescalero and Chiricahua Apache (Castetter and Opler 1936:43; Opler 1941:358) indicate usage in times of unusual want, or especially when other foods were not abundant. On the other hand, Hrdlicka (1908:22) observed that the Mescalero and Jicarilla Apache ate inner bark "even when not in great want". Each of the above cited references indicate that the strips of inner bark were eaten fresh or made into a flour and baked as cakes. An exception is Cushing's (1920:223) account, which is a detailed description of the Zuni cooking inner bark strips with meat by boiling them in water in "closely-plaited basket vessels" with heated rocks.

The most detailed description of inner bark utilization and methods of procurement, based on direct information from native informants, is a paper by Thain White (1954), *Scarred Trees in Western Montana.* White's main informant was Babtiste Mathias, a Kutenai born in 1879, who recalled collecting inner bark in the spring as a child.

Mathias produced two tools for White that he said were used for debarking and scraping. One was a wooden pole, sharpened on one end, that Mathias said was normally about 3 meters long, and was used for prying large slabs of bark off the trunk. The other tool was a hand held implement, approximately 11 centimeters long and 7 centimeters wide, that was used to scrape the inner bark from the bark slab or the tree trunk. Mathias made the scraping implement out of a flattened tin can, but White stated that earlier tools may have been made of mountain sheep *(Ovis canadensis)* horn.

White's paper is a wealth of information on inner bark utilization in western Montana, and a number of particularly interesting points are brought to light. For example, White's informants indicate that the peeling was primarily a strong woman's task, and that children helped their elders as they could. The peeling was carried out in the spring, usually in May and coinciding with the bitterroot season, because the sap in the trees was running at this time and they were easy to peel. The peeling was generally done near campsites, probably because it was carried out by women and children. The trees were first sampled by peeling a small test strip to determine if the trees were "good". The scraping of the inner bark was done at the site of the trees because the large bark slabs were too heavy to carry back to camp. The strips of inner bark were rolled into balls and stored in green leaves to prevent drying, or they were tied into knots so that they could be eaten more easily. White's informants state that inner bark was sweet and tasted good, and the overall impression is that it was a delicacy that was looked forward to and exploited every year. No mention is made of inner bark as an emergency food.

White indicates that the peeling of trees was discouraged by authorities at the time of white settlement because of damage to the trees. He suggests that the practice may also have been abandoned at this time because the availability of processed sugar replaced inner bark as a sweet in the Kutenai diet.

White (1954:7-9) also reported that peeled trees could be found along nearly every valley in western Montana and northern Idaho, and that this area seemed to be the center of inner bark utilization in the west. If the inner bark of pine trees was utilized in a regular fashion, year after year, it seems reasonable to expect that peeled trees would not be rare within an area used by people that followed this practice. Although peeled trees in the Southwest cannot be said to be very rare, they do not seem to be nearly as common as in Montana.

A major problem of studying peeled trees is the fact that logging and other disturbances have probably significantly altered the distribution and abundance of these trees in many areas. Therefore, inventories of numbers and distributions of peeled trees, as well as tree-ring sampling for estimating peeling dates, may reflect this bias. In some cases it may be possible to research past timber cutting activities in an area to determine if this may be a factor. Large protected areas that have never been logged, such as federal Wilderness Areas and Parks, may provide the best opportunity for avoiding a sampling bias in studies of peeled trees.

In any case, considering the reported abundance of surviving peeled trees in Montana, and the first-hand reports of White's Kutenai informants, it is probable that inner bark utilization in this area was on a regular seasonal basis. Indeed, for some native peoples, during some periods, it may have been true that annual use and emergency use of inner bark were the same thing, because food was very scarce every year during certain seasons. This type of situation, however, seems to be different than that described by White's informants, who imply that inner bark was a treat, and would have been eaten regardless of whether food was unusually scarce or not.

Eidlitz (1969:54-59) presents a wide ranging discussion of inner bark utilization in circumpolar areas, including numerous references to its use in Scandanavian countries.

Russia, Canada and Alaska. Even though some of these citations indicate an annual utilization pattern, in the majority of cases the predominant pattern of use seems to have involved times of food scarcity. It may be that in circumpolar areas, where food availability is more limiting during certain seasons than in temperate regions, inner bark provided much needed nourishment. In other words, the high frequency of inner bark utilization among circumpolar peoples may have reflected a situation where annual use of inner bark was a necessity. Whether or not this was the case for other Native Americans, such as the Kutenai, is questionable.

There is also the question of just how "good" inner bark is. Of course taste is a subjective matter, but the fact that White's informants stated that the trees were "tested" before peeling is some indication that not all trees tasted "good". Quantities of sugars and other chemical constituents of inner bark tissues, such as tannins and monoterpenes, vary between species and individual trees and may affect the sense of taste. Gaertner (1970:69-70) experimented with flours made from inner bark of pine *(Pinus strobus* L.) and balsam fir *(Abies balsamea* (L.) Mill.), and cited a Forest Service study that listed the percentage of reducing sugars in oven-dry-weight of pine bark as varying between 22 and 43%. However, she expressed her opinion that pine inner bark had a "disagreeable and strong flavour" because of the tannin-filled cells of the secondary phloem and resin canals that are encountered if more than the innermost layers of bark are included.

The living inner bark tissue, composed of phloem, cambium and perhaps some current years xylem cells, is likely to be a more valuable food source than the non-living outer bark or xylem cells because the living cells contain a variety of chemical constituents that may be of some nutritional value, especially the relatively high concentrations of sugars in the sieve tubes of the phloem (Noggle and Fritz 1983:331-332).

Both Cushing (1920:223) and Standley (1912:448) observed that pine inner bark was difficult to digest. Dimbleby (1967:30-31) stated that inner bark is rich in proteins and carbohydrates in the spring when the active growth period of the tree is beginning. However, when commenting on its possible medicinal properties he said: " . . . far from being a palliative for digestive troubles, is liable to cause them if exclusively used."

In addition to considerations of taste, nutrition, and digestability, the time and effort required to procure and prepare inner bark as a food may also have had a bearing on the value that people ascribed to it. Gaertner (1970:71) stated that the process of procuring and preparing inner bark as a flour, which according to many of the cited ethnographic sources was a commonly used form, was a time consuming and laborious task and could be recommended only in times of wheat flour shortage.

DENDROCHRONOLOGICAL DATING OF PEELING SCARS

Necessary Sampling and Dating Techniques. Peeled trees are unique among the many types of artifacts created by people in their search for food, in that it is possible, by using dendrochronology, to date their utilization to the year. Sampling peeled trees with increment cores, however, requires an intensive and careful technique. In order to obtain accurate estimates of peeling dates using increment core samples, I have found that it is necessary to obtain cores from the curled healing portion of the wound alongside the exposed surface of the peeling, and from the opposite, uninjured side of the tree (Fig. 2). The objective is to obtain an increment core that intersects the scar created by the peeling very near to the original boundary because when the bark was stripped off the tree, one or several rings may also have been removed from the wood of the trunk. Erosion by weather or fire may also have removed wood.

It is often very difficult to penetrate the resinous, dried exposed surface of the peeling with an increment borer (Fig. 2, point D). The dried outer rings on a core from this area are usually destroyed by the cutting tip of the bit, or they often break off from the

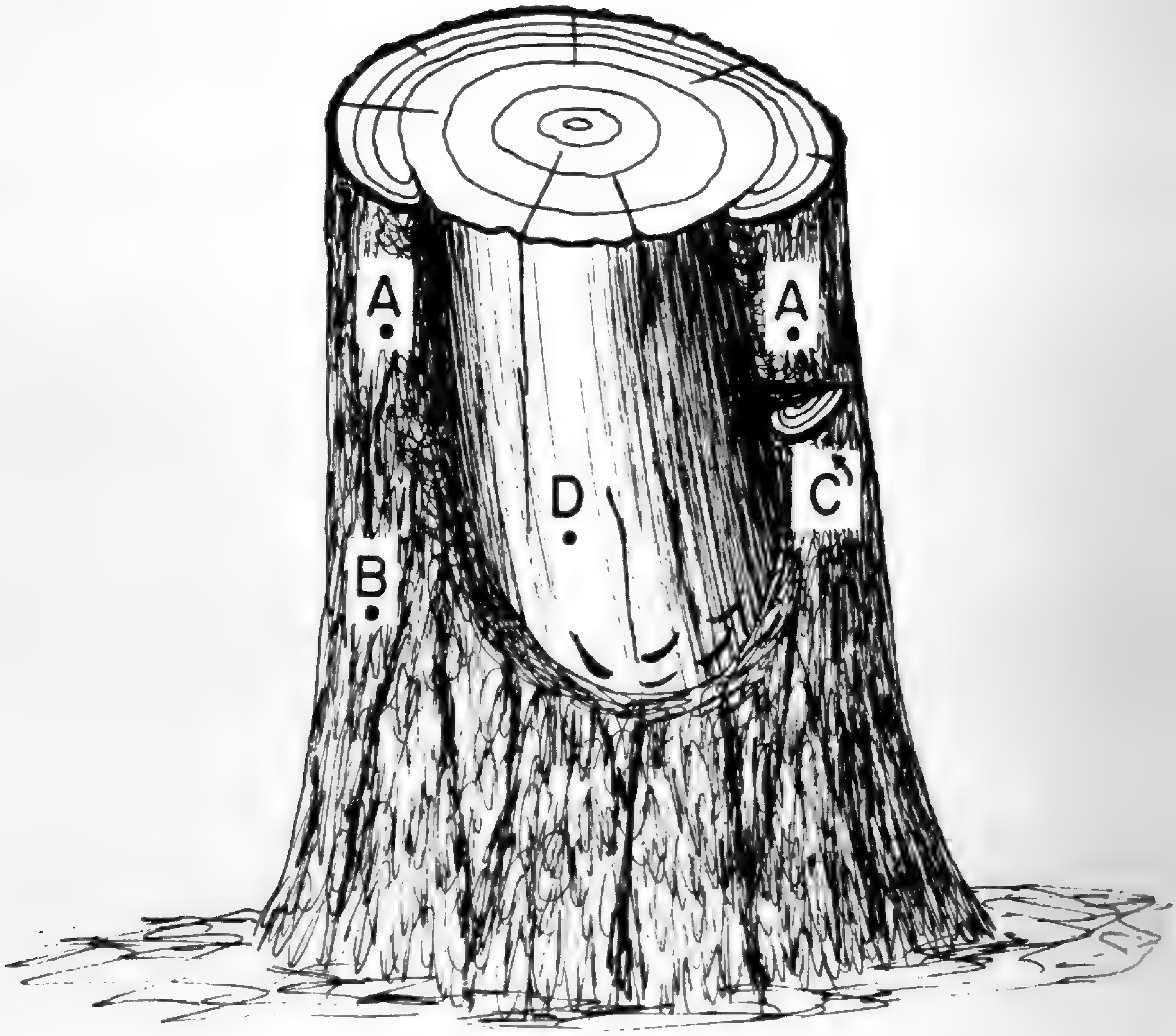


FIG. 2–Increment core sampling is recommended at positions A and B. White (1954) obtained increment cores from the sides of the peeling scar – A, and he also notched some of his sample trees – C and then counted the annual rings from the bark in to the scar. Martorano (1981) obtained increment cores from the exposed surface of the peeling – D, and from the uninjured side of the tree – B.

rest of the core and are lost. Therefore, increment cores taken directly from the exposed surface of the peeling generally provide a date that is earlier than the actual peeling date.

Dating the peeling event by counting on crossdating the rings from the bark in to the break casued by the scar is generally not reliable because the rings are often very distorted along the curved portion of wood, and one to several rings may not appear near the wound. It is best to core through the curled portion of the trunk on the sides of the wound and penetrate into the tree as near to the pith as possible, so that a sequence of rings extending from the pith area out to the original scar surface can be otained for crossdating. Crossdating, as distinguished from simple ring counting, is a method of matching ring-width patterns within and between trees, so that growth anamolies such as locally absent or false rings can be accounted for, and accurate dates of formation can be assigned to individual annual rings (Douglass 1941).

Figure 3 is a schematic illustration of a peeling scar and what is typically observed when a series of increment cores is taken near the edge of the wound. Even when a series of increment cores is taken from the area of the original wound boundary, the estimated peeling dates among the cores may differ by several years. In this case, the latest estimated peeling date is probably the closest to the actual peeling date.

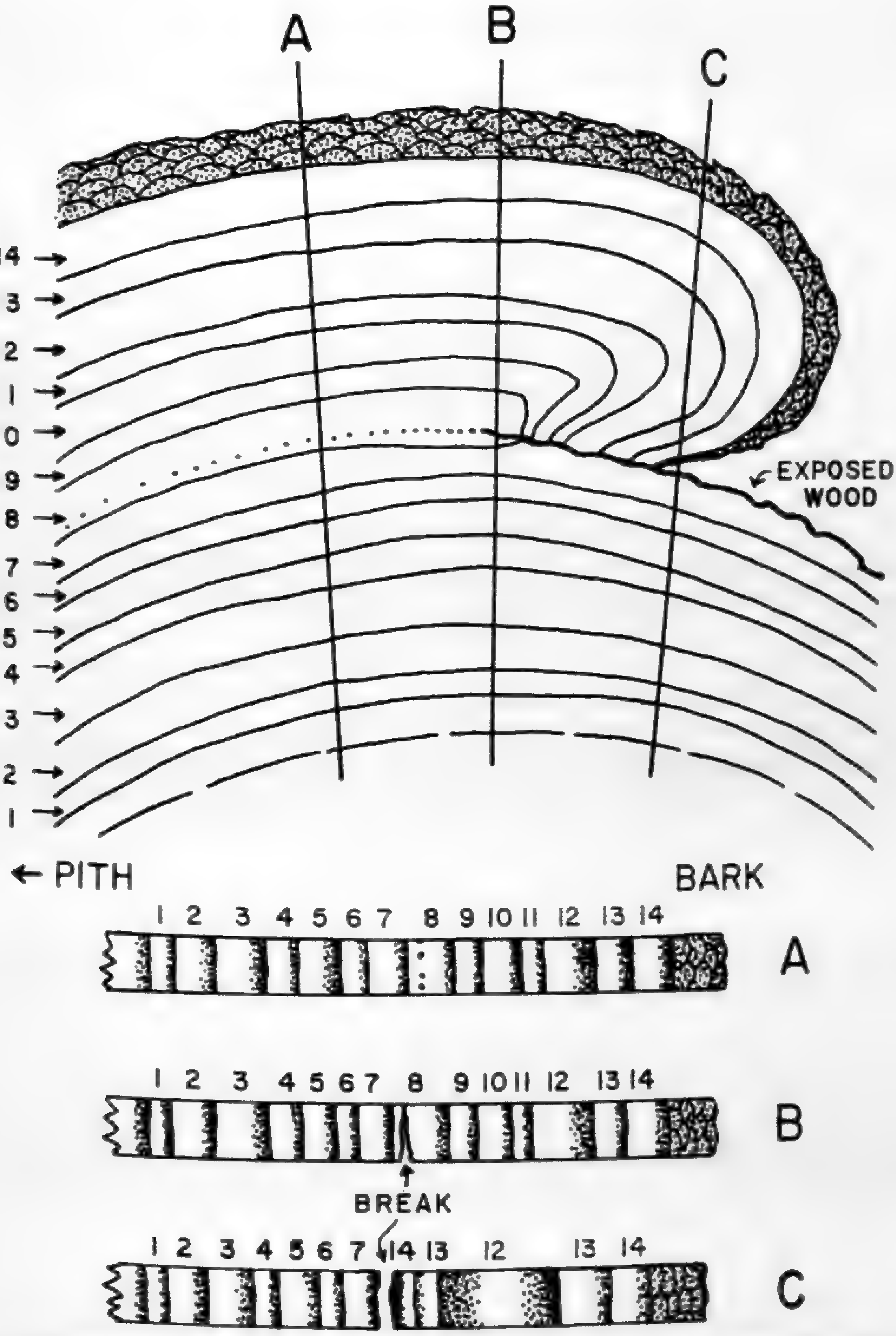


FIG. 3–An increment core taken along radius A would not intersect the original wound boundary and the core would not have a break caused by the exposed surface. The ring containing the scar may have features such as damaged tracheid cells or traumatic resin ducts. A core from radius B would be very close to the original wound boundary and may show the peeling scar entering the correct ring. A core from radius C would include a break, but the last visible ring before the break may be one or more years earlier than the actual peeling date. Note that the ring sequence from the bark in to the break will not include annual rings 8-11, and rings 13 and 14 may actually appear twice!

In addition to the difficulties of intersecting the original wound boundary with an increment borer, scarred trees are frequently very resinous, and many have heart rot or insect galleries, thus the increment borer often becomes jammed with broken pieces of core and resin. Because of these problems, it is very difficult to obtain the exact date of any type of event that scars a tree using only increment cores. Cross-sections are preferable to cores because the entire scarred area is visible and the exact ring where the wound enters can usually be determined. Unfortunately, taking a cross-section obviously destroys living trees.

Interpretation of Peeling Dates. The distribution of peeling dates, arrived at by careful sampling and crossdating, can potentially provide a test of utilization patterns. For example, if the trees in a particular area were peeled on a regular, or annual basis, then many different peeling dates spread out over long periods of time may be expected. On the other hand, if the trees were peeled on an irregular, or emergency basis, then the peeling dates should cluster around one or a few years, or a certain period.

White (1954) attempted to estimate the peeling dates of 47 trees from the locality of Flathead Lake, Montana. He used two techniques for dating the peelings. One technique involved notching the sides of the wound with a handaxe and counting the annual rings from the bark in to the scar. The other technique involved taking increment cores through the bark along the sides of the wound, and presumably counting the rings from the bark in to the appearance of a break caused by the original peeling (Fig. 2). The peeling dates White arrived at varied from an early date of 1739 to 1928. Only a few of White's peeled trees have the same estimated peeling date, although most of the dates appear to cluster during the period 1880 to 1910. There is some uncertainty, however, about the accuracy of White's estimates because he counted only the annual rings from the bark into the wound and did not crossdate the ring width patterns.

A recent study in Colorado involved an extensive survey of three groups of trees that were probably peeled by Ute Indians (Martorano 1981). Martorano measured and analyzed numerous physical features of the peeling scars on 84 trees, and also attempted to estimate peeling dates. She cored through the exposed surface of the wound, and through the bark somewhere along the uninjured side of the tree (Fig. 2). The paired increment cores from the exposed face of the peeling and from the uninjured side of 39 trees were compared and crossdated to estimate the peeling dates. The estimated dates of these trees varied from 1793 in one group to 1959 in another, although she indicated that the later date was questionable, because the scar did not appear to be that recent.

For two groups of trees located in south-central Colorado Martorano obtained many different peeling dates spread out over relatively long periods of time, although there were also clusters of dates from about 1820 to 1830, and gaps without any dates. She hypothesized that these trees were peeled by the Ute on an annual or semi-annual basis. The other group of trees from north-central Colorado had peeling dates that were mostly clustered in the 1850 to 1860 period, and she hypothesized that these trees may have been peeled on an emergency basis (Martorano 1981:110-113).

It can be argued, however, that Martorano's peeling dates lacked the precision necessary to answer the question of utilization pattern. The Colorado samples were crossdated, which would avoid inaccuracies due to false or missing rings, but since the cores were taken through the exposed surface of the scar, instead of near the original boundary of the wound, it is possible that some of the observed variability in peeling dates is due to the sampling technique. If the dating were more precise it is possible that more peeling dates would cluster around certain years or periods.

It is also worth noting on this point that Indian Agent Michael Steck reported that in 1853 about 40 Ute families (mostly women and small children) were camped on Culebra and Costilla Creeks and were said to be starving, and eating the bark of pine and aspen trees for subsistence (Schroeder 1965:65-66). These drainages are approximately 100 km south of the two groups of trees that Martorano hypothesized were peeled by the Ute on an annual or semi-annual basis. Thus, it is apparent that inner bark was at least occasionally used by Ute for an emergency food.

An additional aspect of sampling peeled trees for dendrochronogical dating, and interpretation of estimated peeling dates, is the problem of distribution of these trees. For example, if only one group of dated trees were peeled on the same year, while many other undated groups were scattered throughout the area, it may not be possible to conclude that the dated group was peeled on an emergency basis, because collectively all of the other trees may have been peeled during many different years over a long period of time. In some areas, it may not be possible to determine whether other peeled trees existed because of past logging activities or other disturbances.

NEW MEXICO PEELED TREES

Locations: The largest group of peeled trees that were sampled is along the bottom of Chimayo Canyon, which is a small drainage approximately 24 km north of Santa Fe. A smaller group of peeled trees is in Escondido Canyon approximately 16 km southwest of Tres Piedras, and the third group of trees is in Lilley Park, near the center of the Gila Wilderness in southwestern New Mexico. Table 2 lists locations (latitude and longitude), the number of trees that were sampled, and approximate total number of peeled trees in each area.

The three locations are all within ponderosa pine forests, although the Chimayo Canyon group is the lowest in elevation (2134 m) and some piñon *(Pinus edulis* Engelm.) and one-seed juniper *(Juniperus monosperma* (Engelm.) Sarg.) are growing near the peeled trees. A perennial stream flows in the bottom of Chimayo Canyon. The Lilley Park and Escondido Canyon groups are higher in elevation (both sites are at 2438 m), have grassy understories, and are near large meadows. A stream flows near the Escondido Canyon trees, and there is a spring near the peeled trees in Lilley Park. All three of the groups of trees are near areas that would likely be attractive campsites.

Sampling and Dating. The New Mexico peeled trees were sampled by taking increment cores from the curled healing portion of the wound alongside the exposed surface of the peeling, and from the opposite, uninjured side of the tree (Figs. 2 and 3). The peeling scars were dated by crossdating the inner portion of the cores taken from the wound area with a master tree-ring chronology established for the area (Stokes and Smiley 1968). The cores from the uninjured side of the tree were also crossdated and used for comparison with the cores from the wounded side. The tree-ring chronologies used were the Upper Rio Grande chronology (Schulman 1956) for the Chimayo Canyon and Escondido Canyon trees, and the McKenna Park, Gila Wilderness chronology (Swetnam 1983) for the Lilley Park trees.

TABLE 2.–*Locations and numbers of New Mexico peeled trees.*

	Location			No. of Trees	
	Lat.	Long.	Elevation	Sampled	Total[1]
Lilly Park	108°28'	33°19'	2438 m	6	12
Chimayo Canyon	105°52'	35°55'	2134 m	12	70
Escondido Canyon	106°13'	36°35'	2438 m	2	20

[1]Total number of trees at each site is an estimate.

Peeling Dates. Table 3 lists the number of trees sampled, the estimated peeling dates of trees that were successfully crossdated and comments and notes on the dating. The Chimayo Canyon trees were very difficult to core because nearly every tree was infested with ants and most of the peeled trees had rot behind the scars. As a result, very few usable cores were obtained and the peelings on only five trees could be dated out of the 12 trees that were sampled. The trees at this site were also climatically stressed, and a number of rings were absent from the cores during years that were probably dry (e.g., 1801, 1818, 1819, and 1822). As it turned out, a number of the usable cores showed peeling scars sometime during the 1818 to 1822 period, and so it was difficult to crossdate these trees with absolute confidence.

Only two trees were sampled from Escondido Canyon. The cores from these trees were free of rot and crossdated well with the Upper Rio Grande chronology. The dates are listed in Table 2.

The Lilley Park trees were also free of rot and they crossdated satisfactorily with the McKenna Park chronology. Only one of the six trees that was sampled was not dated. The undated tree had a very complacent ring series (low variation in ring-widths), and crossdating was not apparent. The Lilley Park sampling is the most complete of the three groups of trees since cores from nearly half of the estimated total number of peeled

TABLE 3.–*Estimated peeling dates of sampled trees.*

Site	Tree ID	Estimated Peeling Date	Comment
Lilley Park	1	1865	possibly 1866[1]
	2	1865	possibly 1866[1]
	3	1865	most reliable date[2]
	4	1865	last visible ring before scar 1864[3]
	5	1865	last visible ring before scar 1864[3]
Chimayo Canyon	1	1818	possibly 1819[1]
	2	1832	dating uncertain[4]
	7	1831	dating uncertain[4]
	8	1857	possibly 1858[1]
	11	1815	dating uncertain[4]
Escondido Canyon	1	1872	possibly 1873[1]
	2	1872	last visible ring before scar 1864[3]

[1]Peeling date may be one year later than estimated date because the core sample may not have been very near the original wound boundary.

[2]Most reliable date for this site because a core included the original wound boundary showing the scar entering 1865 ring.

[3]The last visible ring before the break on the cores was the indicated date, but it was apparent that the cores were not very near the original boundary, so the peeling date was estimated to be one or several years later.

[4]Dating uncertain because absent rings were common in these trees, especially during years near the peeling scars.

trees at this site were dated. Some of the cores from the trees in Lilley Park had a break in the 1864 ring and some had a break in the 1865 ring, but there were indications that these cores were still some distance from the original wound boundary, and so the 1865 or 1866 ring may have been missing. Cores from one tree clearly showed the original wound boundary, with the scar entering the 1865 ring. It is most probable that all of these trees were peeled in 1865 or one year later in 1866.

Historical Evidence. The dating of the Lilley Park trees posed an obvious question. Who were the people that peeled these trees and was their motivation unusual hunger or were they merely exploiting a food resource that they utilized every year or every few years? The first part of this question was easy to answer since the Gila Wilderness was the homeland of the Gila Apache, at least during historic times. The Gila Apache were composed of at least two local groups of Chiricahua Apache, the Mogollon and the Mimbreño, who were linked by intermarriage and other habits (Opler 1941:1; Thrapp 1974:63-64). The second part of the question is somewhat more difficult to answer, but I believe the evidence strongly suggests that the Lilley Park trees were peeled by the Gila Apache when they were unusually hungry.

The primary evidence is historical. Under the leadership of Mangus Coloradas, the Mimbreño Apache were reported to have been involved in the famous battle at Apache Pass in Arizona on July 14, 1862. Following this battle, General James H. Carleton commanding the Union forces of the California Column gave the following orders to Brigadier General Joseph R. West (Thrapp 1974:82): " . . . immediately organize a suitable expedition to chastize what is known as the Mangus Colorado's Band of Gila Apaches. The campaign to be made must be a vigorous one, and the punishment of that band of murderers and others must be thorough and sharp."

Carleton's orders were indeed carried out with vigor during the next year (1863) and numerous battles with the Gila Apache took place within and around the Gila Wilderness (Thrapp 1974:83). Keleher (1952:291) states that by mid-summer 1863: " . . . the Gila Apaches in southwestern New Mexico had been driven back, slowly and relentlessly, from their country, starving and homeless, into the wilds of Arizona and Mexico". However, it is likely that the Gila Apache moved in and out of the Gila Wilderness and vicinity during 1864 and 1865, as it was their home-land and it was also an extremely remote and rugged country which was ideal for hiding out.

Victorio became the leader of the Gila Apache after the murder of the captive Mangus Coloradas by his soldier guards in January 1863. Skirmishes between soldiers and the Gila Apache continued into 1865, when Victorio attempted to make contact with Carleton to discuss peace. Carleton sent an emissary in May of 1865 to talk to Victorio in the Gila area, and he later quoted Victorio as saying (Thrapp 1974:91): "I and my people want peace—we are tired of war—we are poor and we have little for ourselves and families to eat or wear—it is very cold—we want to make peace, a lasting peace . . . " Unfortunately, Carleton was intransigent, and lasting peace did not come until after the death of Victorio and most of his warriors in 1880 in a battle with the Mexican General Terrazas (Thrapp 1974:293-314).

It seems quite clear that the Gila Apache were experiencing unusual hunger during 1865 and 1866. Although the historic evidence is circumstantial, it appears to be a very compelling argument for the emergency food utilization pattern, at least for the Gila Apache and the peeled trees in Lilley Park.

It should also be noted that the Gila Wilderness and adjacent Aldo Leopold Wilderness and primitive areas are quite large (approximately 300,000 ha), and no commercial timber cutting activities have taken place within these boundaries. Although it is likely that there are other peeled trees within these areas, they are certainly not very common, as the Lilley Park trees are the only ones that I have observed on extensive travels through the Gila area. Therefore, the Lilley Park trees probably do not represent a sampling bias because they are only one of many groups of peeled trees in the area, or because of past timber cutting.

Further testing of the hypothesis that any particular group of trees were peeled on an emergency basis, or otherwise, could utilize similar historic evidence, but consideration should be given to the sampling problems. Historic evidence that may explain the peeling of trees at Escondido Canyon or Chimayo Canyon has not yet been pursued to any great length because the sample sizes from these two groups are too small, or the dating too uncertain, to determine whether the majority of trees at these sites were peeled during specific dates or periods. A more intensive sampling of these trees is planned, so that the emergency food hypothesis can be further tested.

SUMMARY

The published references suggest that there were different patterns of cultural utilization of inner bark. Some cultural groups may have peeled pine trees and eaten the inner bark every year because it was valued as a sweet or delicacy. Other groups may have used inner bark only as an emergency food on relatively rare occasions. And yet others may have eaten inner bark every year, or every few years, because of a combination of necessity, cultural tradition, and taste. Inner bark may not have very high nutritive value, digestion of this fibrous material is difficult, and the taste may or may not be appealing. It seems probable that inner bark was not a very important food for Southwestern cultural groups that used it, but it was more likely a minor or peripheral item in the food economy that was more or less exploited depending on the abundance of other foods and customs of the people.

It is my contention that the Gila Apache of southwestern New Mexico utilized inner bark as an emergency food. The dendrochronological dating of one group of peeled trees in the Gila Wilderness, and the historical circumstances of the Gila Apache at the time the trees were peeled, supports this view. I suspect that other groups of peeled trees in the Southwest and elsewhere in the western United States were also peeled by people during years when they were very hungry.

Additional research is needed to determine utilization patterns for any particular people or group of trees. Inventories of the numbers and geographical distribution of surviving peeled trees is needed. If the problem of changes in distribution and abundance of peeled trees in historic times can be avoided, or accounted for, inventories may help to determine the importance of inner bark in the food economy of different cultural groups. The distribution of these trees may also help determine the location of seasonal campsites and movements of nomadic peoples.

Dendrochronology can provide a tool for determining whether groups of peeled trees were exploited seasonally, or during times of unusual food scarcity. Trees that were peeled on an emergency basis can provide evidence that a group of people were experiencing hardship, possibly due to famine brought on by warfare, climate or other circumstances.

I would emphasize that intensive and careful sampling is necessary to obtain usable increment core samples for dating purposes. Crossdating, rather than simple ring counting, is also necessary to arrive at accurate dates because missing and false rings are not uncommon in trees, especially trees that have suffered large wounds on their trunks. Cross-sections or wedge-sections from peeled trees would greatly facilitate the dating of peeling events. Destructive sampling of living trees may not be acceptable, but it is possible that cross-sections could be taken from standing dead trees or downed logs with peeling scars. With cross-sections, it may also be possible to determine whether trees were peeled during the dormant season (fall, winter and early spring) or during the growing season (late spring and summer) by noting the relative position of the peeling scar within the annual rings.

Finally, it should be recognized that there is some urgency in the task of identifying peeled trees and preserving them where it is possible to do so. No doubt many of these trees have been cut down for lumber over the years, without any recognition of their cultural or historical significance. Timber cutting activities have increased in recent years within the few remaining virgin, old growth stands of ponderosa pine. These are the areas where peeled trees are most commonly found.

ACKNOWLEDGEMENTS

I thank Thomas P. Harlan, James R. Swetnam, John H. Dieterich and Elaine Kennedy Sutherland for their help in collecting the increment core samples. Thomas P. Harlan of the Laboratory of Tree-Ring Research also helped crossdate the Lilley Park and Escondido Canyon cores. Fred R. Swetnam identified the locations of the Chimayo and Escondido Canyon trees, and Jack Stellar kindly permitted us to core the Chimayo Canyon trees on the Frank Rand Boy Scout Ranch. I also thank Karen R. Adams, Marilyn A. Martorano, Bryant Bannister, Jeffrey S. Dean, William J. Robinson and an anonymous reviewer for their comments and suggestions. Figs. 2 and 3 were drawn by Susanmarie Clark.

LITERATURE CITED

CASTETTER, EDWARD F. 1935. Uncultivated native plants used as sources of food. Univ. of New Mexico Bull. No. 266, Biol. Ser. Vol. 4, No. 1, Ethnobiological Studies in the American Southwest, No. 1.

———— and MORRIS E. OPLER. 1936. The ethnobiology of the Chiricahua and Mescalero Apache. Univ. of New Mexico Bull. No. 297, Biol. Ser., Vol. 4, No. 5, Ethnobiological Studies in the American Southwest, No. 3.

CUSHING, FRANK H. 1920. Zuni breadstuff. Indian Notes and Monographs, Vol. 8, New York Museum of the American Indian.

DIMSLEBY, G. W. 1967. Plants and archaeology. Unwin Brothers Limited, Pall Mall, London.

DOUGLASS, ANDREW E. 1941. Crossdating in dendrochronology. J. For. 39(10):825-831.

EIDLITZ, KERSTIN. 1969. Food and emergency food in the circulpolar area. Studia Ethnographica Upsaliensia, Vol. 32. Almqist and Wiksells, Uppsala, Sweden.

GAERTNER, ERIKA E. 1970. Breadstuff from fir *(Abies balsamea)*. Econ. Bot. 24(1): 69-72.

HRDLICKA, ALES. 1908. Physiological and medical observations among the Indians of the Southwestern United States and Northern Mexico. Smithsn. Inst., Bur. of American Ethnol. Bull. No. 34.

KELEHER, WILLIAM A. 1952. Turmoil in New Mexico: 1846-1868. The Rydal Press, Santa Fe, New Mexico.

MARTORANO, MARILYN A. 1981. Scarred ponderosa pine trees reflecting cultural utilization of bark. Master of Arts Thesis, Dept. of Anthro., Colorado State Univ., Fort Collins.

NEWBERRY, JOHN S. 1887. Food and fiber plants of the North American Indians. Pop. Sci. Monthly 32:31-46.

NOGGLE, G. RAY and GEORGE J. FRITZ. 1983. Introductory plant physiology. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

OPLER, MORRIS E. 1941. An Apache lifeway: The economic, social, and religious institutions of the Chiricahua Indians. The Univ. of Chicago Press, Chicago, Illinois.

SCHROEDER, ALBERT H. 1965. A brief history of the southern Utes. Southwestern Lore 30(4):53-78.

SCHULMAN, EDMUND. 1956. Dendroclimatic changes in semi-arid America. Univ. of Arizona Press, Tucson.

STANDLEY, P.C. 1912. Some useful native plants of New Mexico. Smithsn. Inst. Ann. Rept. 1911:447-462.

STOKES, MARVIN A. and TERAH L. SMILEY. 1968. An introduction to tree-ring dating. Univ. of Chicago Press, Chicago.

STURTEVANT, E. L. 1919. Sturtevant's notes on edible plants. (U.P. Hedrick, ed.), New York State Dept. Agr. Ann. Rept. (1918-19), No. 27, Vol. 2(2).

SWETNAM, THOMAS W. 1983. Fire history of the Gila Wilderness, New Mexico. Master of Sci. Thesis, Sch. of Ren. Nat. Res., Univ. of Arizona, Tucson.

LITERATURE CITED (continued)

THRAPP, DAN L. 1974. Victorio and the Mimbres Apaches. Univ. of Oklahoma Press, Norman.

THWAITES, R.G. (ed). 1905. Original journals of the Lewis and Clark Expedition, 1804-1806. Vol. 3 and 5., Dodd, Mead and Company, New York.

WHITE, THAIN. 1954. Scarred trees in Western Montana. Montana State Univ. Anthro. and Sociol. Pap. No. 17.

Book Review

Ralamuli Nutugala Go'ame (Comida de Los Tarahumaras). Albino Mares Trias. Published privately by: Don Burgess McGuire, 911 12th Street, Safford, Arizona 85546. 1982. 502 pp. $10.00.

Most ethnobiological works are written by outsiders who come from very different cultures, and who have to struggle to understand the ways of the people they are studying. This book, however, the fourth written by Mares, a Tarahumara of Guazapares, Chihuahua, Mexico, discusses over 100 edible plants, fungi, and caterpillars, both wild and domesticated, consumed by the natives of the author's home area. It is written in the native Tarahumara language with a parallel text in Spanish, and contains descriptions of the different varieties of each species, and the manner in which each is utilized, plus photographs of most of the species. Most of the photographs are excellent, although a few did not reproduce very well. The book also includes an introduction by Don Burgess McGuire of the Summer Institute of Linguistics, and an appendix by Dr. Robert Bye of the University of Colorado, listing the scientific binomials of most of the species discussed.

Written by a nonprofessional, the book does tend to be a bit folksy in spots, although it appears rather thorough in what it attempts to do. The appendix is difficult to use, with no apparent order to the listings. The book is interesting primarily because of its novelty, and because if its inherently emic point of view, which is unusual in ethnobiological literature.

Joseph E. Laferriere
Department of Ecology &
Evolutionary Biology
University of Arizona
Tucson, Arizona

J. Ethnobiol. 4(2):191-200 December 1984

UTAH JUNIPER *(JUNIPERUS OSTEOSPERMA)* CONES AND SEEDS FROM SALMON RUIN, NEW MEXICO

DAVID L. LENTZ
Scanning Electron Microscopy Laboratory
School of Dentistry
University of Mississippi
Jackson, MS 39216

ABSTRACT.–Morphometric comparisons with modern species reveal that ancient juniper seeds and cones discovered at Salmon Ruin, New Mexico, are *Juniperus osteosperma* (Utah juniper). Ethnographic sources for Southwestern Native Americans indicate that juniper cones are used for food, medicine, and other purposes. Evidence is presented for a similar utilization pattern of juniper cones by the prehistoric Anasazi inhabitants of the ruin. Cones and seeds have been found in a variety of archaeological contexts, including stratigraphic units from the Tower Kiva, burials, storage or processing areas, and trash deposits.

INTRODUCTION

During extensive archaeological excavations at Salmon Ruin, New Mexico, more than 1600 juniper cones and seeds were unearthed. These abundant plant remains provide evidence concerning the use of juniper cones by the prehistoric inhabitants of Salmon Ruin. A greater understanding of this archaeobotanical evidence is brought into focus through the integration of information on juniper taxonomy, regional topography, plant ecology, and ethnographic accounts of traditional Southwestern Native American plant-use practices.

Salmon Ruin is a prehistoric Puebloan site located 16 km east of Farmington in the northwest corner of New Mexico. The site is on the eastern side of the Colorado Plateau and is just north of the San Juan River flood plain. Elevations in the area range from 1900 m by the river to 2200 m on the higher escarpments above the site.

The dwelling, a multicomponent site, was built in the late 11th century A.D. and was first inhabited (primary occupation) by Anasazi groups associated with the Chaco Canyon cultural manifestation (Irwin-Williams 1977). The E-shaped, pueblo-style edifice (Fig. 1) was later inhabited in the 13th century and partially modified by another group, the Mesa Verde Anasazi (secondary occupation). The occupations were identified by pottery styles associated with early and late stratigraphic levels.

PLANT ECOLOGY

Above the flood plain to the north and south of the San Juan River Valley are ancient terraces that have been carved out of the plateau by the westward flowing river. The principal plant community of the terraces has been variously described as pigmy forest (Woodbury 1947), pinyon-juniper woodland (Howell 1941; Randles 1949; Zarn 1977), and juniper-pinyon savanna (Daubenmire 1943). Visual dominants of the community are, as some of the names suggest, pinyon *(Pinus edulis* Engelm.) and junipers *(Juniperus* spp.), the latter being much more numerous. *J. osteosperma* (Torr.) Little, Utah juniper, was the only representative of its genus found within 10 km of Salmon Ruin. A small stand of *J. monosperma* (Engelm.) Sarg., one-seed juniper, was located 15 km to the southeast of the site, but other juniper species that might have been expected in the region, i.e., the alligator juniper *(J. deppeana* Steud.) and Rocky Mountain

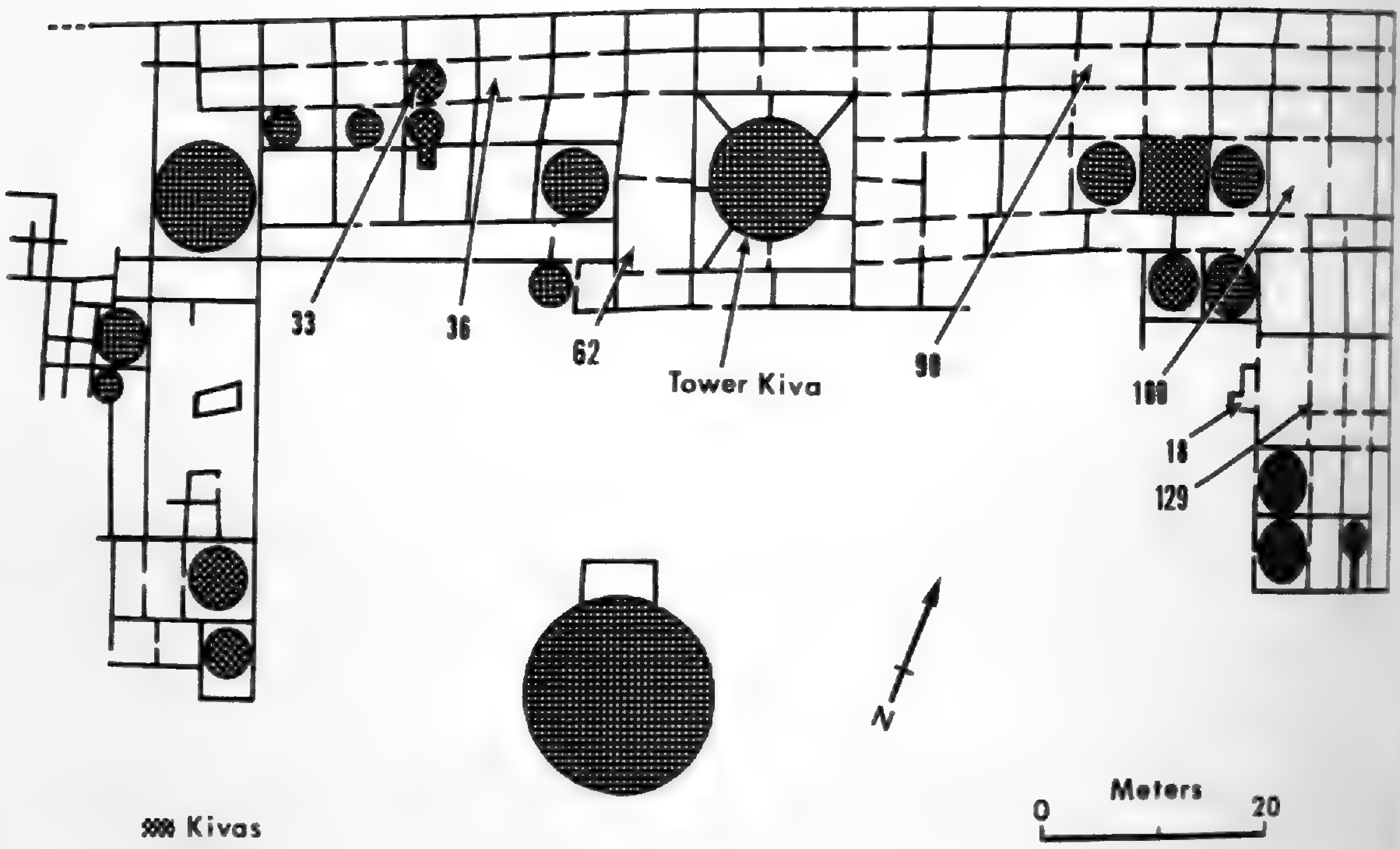


FIG. 1.–Floor plan of Salmon Ruin showing selected rooms containing juniper seed macrofossils. Room numbers are referred to in the text.

juniper (*J. scopulorum* Sarg.) were not observed despite intensive botanical surveys. Within 10 km of Salmon Ruin there are approximately 156 km (50% of the land area covered with pinyon-juniper woodland, or what might more accurately be called Utah juniper woodland with a few small stands of pinyon mixed in.

JUNIPER SEED IDENTIFICATION

Reference seeds from modern junipers were collected to compare with the ancient seeds from Salmon Ruin. Since almost all the Salmon Ruin seeds were round in cross section, alligator and Rocky Mountain junipers were excluded as possible species of origin. Each of these species usually has two or more seeds per cone (Kearney and Peebles 1951; Little 1950), resulting in distinctive flattened areas, or facets, on their seeds. Utah and one-seed junipers usually have one seed per cone and are isodiametric. Morphologically, the latter two species have seeds that are quite similar, although Utah juniper seeds tend to be larger than one-seed juniper seeds.

To determine the species of the Salmon seeds, maximum length and width measurements for modern one-seed and Utah junipers were compared to those of the unbroken ancient seeds. Seed length and width were multiplied together, forming an index, to accentuate the size differences and simplify the data (Table 1). A Tukey-Kramer pairwise comparison (Sokal and Rohlf 1969) of the three populations listed in Table 1 reveals highly significant differences ($P<0.01$) among all three groups. Nevertheless, the seeds from Salmon Ruin must be from at least one of the species represented in the comparison. An inspection of the frequency polygons of the three seed populations (Fig. 2) reveals the similarities between the Utah juniper curve and the Salmon juniper seed curve, especially at the lower ends. If there were a number of one-seed juniper seeds in the Salmon seed collection, the curve of the latter would take on a bimodal configuration, the variance would be increased, and seeds would appear in the strictly one-seed juniper size range. However, this was not the case.

Although, the Salmon seed-size index mean is larger than the mean for modern Utah juniper seeds, this disparity can be explained. The modern seeds were collected during a dry year, 1977, with 33.3 mm lower than average rainfall (U.S. Department of Com-

TABLE 1.—*Size index (length in mm x width in mm) calculations for sample populations of juniper seeds.*

	Juniperus monosperma (modern collection)	*J. osteosperma* (modern collection)	Juniper seeds from Salmon Ruin
Mean	14.75	35.50	38.65
Standard Deviation	2.98	9.74	8.12
Variance	8.96	94.77	65.91
Median	14.28	36.00	38.55
Minimum Value	6.21	10.40	13.69
Maximum Value	23.37	63.00	66.00
Number of Seeds Counted	210	283	1180

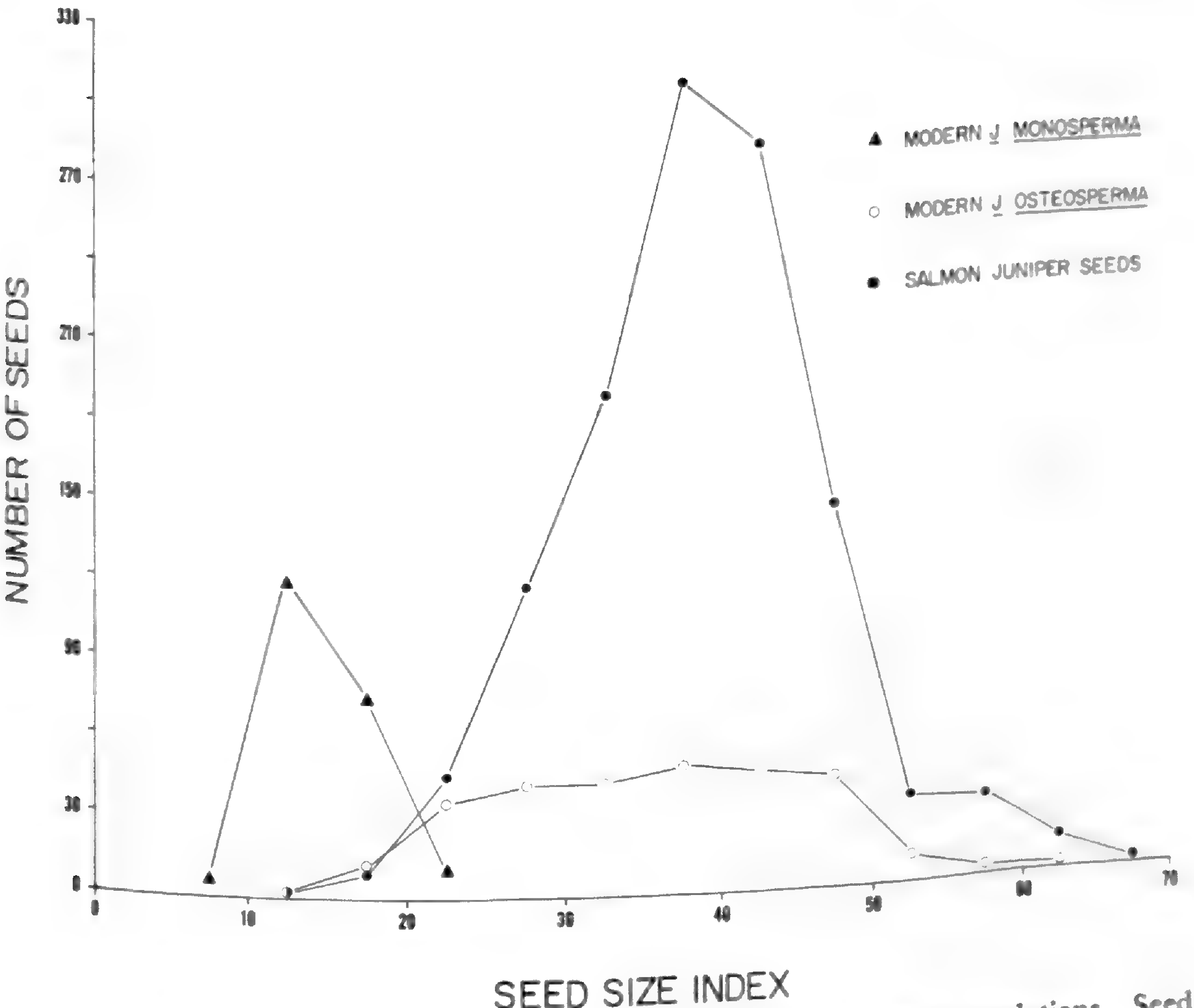


FIG. 2.—Graph showing frequency polygons for three juniper seed populations. Seed index = length in mm x width in mm.

merce 1977). The preceding year was even drier, with an 81.3 mm rainfall deficit (U.S. Department of Commerce 1976). In this arid region, even a small drop in rainfall has substantial ramifications as preciptation averages only 264 mm per year. Probably the seed size of the juniper crop was adversely affected. The modern juniper seeds were collected during a dry year and were smaller than average whereas the juniper seeds from Salmon were collected over many years and undoubtedly reflected a closer approximation to the true population mean.

ETHNOGRAPHIC SOURCES AND ARCHAEOBOTANICAL INTERPRETATION

Most traditional Southwestern Native Americans use juniper cones for food, medicine, or ornamentation. The extensive ethnographic literature relating to juniper cone use is outlined in Table 2. Assuming that plant use practices of present day Native Americans are similar to those of the past, ethnographic information can aid in the interpretation of archaeobotanical data.

TABLE 2.—*Use of juniper cones and seeds by Southwestern Native Americans.*

Native American group	Species of *Juniperus*	Use, method of preparation or storage technique	References
Hopi	*J. osteosperma*	cones baked with piki bread, seeds used as beads for necklaces	Whiting 1939
Tanoan Pueblo (Jemez)	*J. scopulorum*	cones eaten fresh or stewed	Cook 1930
Tanoan Pueblo (San Juan)	*J. communis*, *J. monosperma*	cones eaten fresh	Ford 1968
Tanoan Pueblo (Isleta)	*J. deppeana*	cones boiled then eaten	Jones 1931; Castetter 1935
Tanoan Pueblo (Santa Clara)	*J. monosperma*	cones eaten fresh or heated in an open pan over a fire, decoction in water used as remedy for internal chills and as a diuretic	Robbins et al. 1916
Tanoan Pueblo (Santa Clara)	*J. monosperma*	cones eaten fresh	Hough 1931
Tanoan Pueblo (San Ildefonso)	*J. monosperma*	cones eaten fresh (?)	Robbins et al. 1916
Keres Pueblo (Sia)	*J. monosperma*, *J. scopulorum*	cones eaten fresh or cooked	White 1945
Keres Pueblo (Cochiti)	*J. monosperma*	cones eaten fresh or baked, tea used as a cold remedy and as a tonic after childbirth	Castetter 1935

TABLE 2.—*Use of juniper cones and seeds by Southwestern Native Americans.* (Continued)

Native American group	Species of *Juniperus*	Use, method of preparation or storage technique	References
Keres Pueblo (Acoma, Laguna)	*J. monosperma*	cones eaten fresh or mixed with chopped meat and roasted	Swank 1932; Castetter 1935
Western Apache	*Juniperus sp.*	cones an important wild food	Goodwin 1942
Western Apache	*J. osteosperma*	cones eaten fresh, stored in sealed baskets	Basso 1969
Western Apache	*J. monosperma*	cones eaten fresh, seeds spat out, beverage derived from dried cones mixed with water, cones sun dried and stored for winter	Gallagher 1977
White Mountain Apache	*J. monosperma*, *J. osteosperma*, *J. occidentalis*	cones boiled before eating	Reagan 1929
San Carlos Apache	*Juniperus* spp.	cones boiled before eating	Hrdlicka 1908
Northern and Southern Tonto	*Juniperus* spp.	cones eaten fresh	Gifford 1940
Navajo	*J. monosperma*, *J. osteosperma*	cones eaten fresh, boiled juice used as a cure for influenza, as a source of green dye; seeds used as beads for necklaces	Elmore 1944
Ramah Navajo	*J. monosperma*, *J. deppeana*	cones eaten fresh, boiled, roasted and also stored for winter use	Vestal 1952
Gosiute	*J. osteosperma*	cones eaten after boiling	Chamberlin 1911
Southern Paiute	*J. osteosperma*	trees sampled for sweetest cones; cones crushed on a metate, seeded, then eaten	Kelly 1964

Table 3 contains data from several Salmon Ruin stratigraphic units, illustrating the kinds of activities with which juniper cones were associated as suggested by the ethnographic literature. The units were selected on the basis of their stratigraphic integrity, favorable preservation qualities, and absence of rodent disturbance indications. By selecting strata according to these criteria, the modifying effects of post-depositional factors have been minimized.

TABLE 3.—*Selected strata from Salmon Ruin containing juniper seeds and cones.*

Room number	No. juniper remains	Stratigraphic unit	Archaeological context	Occupational component	Juniper use interpretation	Associated macrofossils
18[a]	2[s]	L1-08	burial (juniper seeds next to the skull)	secondary	grave offering	*Yucca* leaves
33	2[k]	L1-11.5	burial	primary	grave offering	Brush of monocotyledon leaves; prayer sticks; bow and *Phragmites* arrow shaft
36	2[ck]	F1-15	burned store room	secondary	stored food	*Zea mays* cobs and kernels; *Phaseolus vulgaris* seed, *Cucurbita* rind, *Cycloloma* seed; *Opuntia* spp. stems and seeds; *Phragmites* stems; *Yucca* leaf bundle
62	784[s] 68[k] 8[sc]	43 strata	trash	primary and secondary	discarded food remains	*Zea mays* cobs and kernels; *Cucurbita* seeds and rinds; *Pinus edulis* testa; *Allium* bulb scales; *Prunus* pits; *Yucca* seeds and leaves; *Xanthium* fruits; *Opuntia* spp. stems and seeds; other plant remains
64[b]	7[cs] 1[ck]	H1-08	burned activity surface	secondary	food, ceremonial use or medicinal use	*Zea mays* cobs; *Phaseolus* pods; *Cucurbita* rinds and seeds; *Mentzelia albicaulis* seeds; *Yucca* leaves; *Pinus edulis* testa; basketry
90	2[s]	F2-09	burned store room	secondary	food or food refuse	*Zea mays* cobs and kernels; *Phaseolus vulgaris* seed; *Chenopodium* seed; *Xanthium* fruit

TABLE 3.—Selected strata from Salmon Ruin containing juniper seeds and cones (continued)

Room Number	No. juniper remains	Stratigraphic unit	Archaeological context	Occupational component	Juniper use interpretation	Associated macrofossils
100	1[ck]	N1-03	outdoor processing or storage area, burned rooftop	secondary	food	*Zea mays* cobs, kernels, tassel, peduncle, knotted leaves; *Phaseolus vulgaris* seed; *Cucurbita* rind and peduncle; *Atriplex* seed; *Opuntia* bud; *Cycloloma* seed; *Yucca* cordage
129	1[ck]	F1-08	burned store room	secondary	food	*Zea mays* kernels, cobs, and tied husks; *Phaseolus vulgaris* seed; *Cucurbita* seeds and rinds; *Xanthium* fruit; *Chenopodium* seed; *Opuntia* bud; monocotyledon leaves (quid); grass stems, evenly cut; *Yucca* stem heart, leaves, twine; matting

[a]Test Trench [b]Tower Kiva [c]Carbonized [s]Seeds [k]Seeds with cone parts attached

Modern Southwestern Native Americans often cook juniper cones by boiling or roasting them. The prehistoric Salmon Ruin inhabitants seem to have done the same. Over 200 of the juniper cones and seeds found at the site were carbonized (Fig. 3). Several trash strata in Room 62 contained carbonized and uncarbonized juniper seeds, as well as other plant macrofossils, embedded in matrices of ash. These units represent redeposited hearth refuse. Since juniper seeds are regarded as waste products according to ethnographic sources, it should not seem surprising to find the seeds in prehistoric midden deposits. Room 62 contained 53 trash strata and 43 of these included juniper seeds, suggesting the early inhabitants also discarded them. The fact that many of the juniper seeds found at Salmon Ruin are uncarbonized indicates fresh consumption of the cones by the prehistoric inhabitants similar to patterns revealed in the ethnographic literature. The durable nature of the seeds combined with the xeric conditions of the region can account for the preservation of these plant artifacts.

FIG. 3–Utah Juniper cones and seeds. From left to right: modern cone, modern seed, carbonized cones from Salmon Ruin, seed from Salmon Ruin.

Ethnographic sources show that juniper cones are sometimes sun dried (Gallagher 1977) and stored for winter use (Vestal 1952). One secondary rooftop (Room 100) at Salmon Ruin with juniper remains evidently served as an outdoor processing area (Bohrer 1980). Also, juniper seeds were discovered in three burned storerooms (36, 90, and 129), indicating the early inhabitants may have desired a reserve of the food item.

Juniper seeds were found on an activity surface in the Tower Kiva (Room 64), suggesting that they may have been used for ceremonial purposes. Traditionally, kivas are rooms where rituals are practiced (Vivian and Reiter 1965) and oftentimes artifacts associated with them have ceremonial significance.

Five burials containing juniper seeds and cones were unearthed at the site. All of the burials were enveloped by matting, or the remains thereof, so that these strata were discrete units. For example, stratum L1-11.5 of Room 33 showed evidence for a grave offering with two cones found adjacent to the body inside of what was left of the surrounding matting of the inhumation. In the Southwest, food offerings were often placed in proximity to the deceased (Bohrer and Adams 1977), providing nourishment for the long journey after death (Parsons 1939). The five inhumations at Salmon Ruin containing juniper remains suggest the plant's use as a funerary item.

DISCUSSION

Because of the numerous juniper remains found in a variety of archaeological contexts at Salmon Ruin, it seems apparent that the cones were a part of the prehistoric subsistence pattern of those early inhabitants. Although it seems likely that juniper cones were not a staple for the Salmon Ruin Anasazi, their supplementary role should not be disregarded. Studies comparing plant remains from the primary and secondary occupations indicate an increased reliance on wild foods, such as juniper, by the latter occupation (Doebley 1981; Lentz 1979).

Utah juniper cones have been shown to contain 7.5% reducing sugar (Yanovsky and Kingsbury 1938) and a comparable amount, 10.66%, has been shown for the bread of *J. occidentalis* Hook, with 5.69% protein and 17.87% starch (Palmer 1871). Heat of combustion tests on Utah juniper cones from the Salmon Ruin area reveal the presence of 5.3 kcal/gr in strobilus material (minus the seeds) or 6.5 kcal/cone. Combine this with the estimate of 488 mill cones produced within a 10 km radius of Salmon Ruin (Lentz 1979) during the relatively dry year of 1977, and a substantial, reliable resource appears to have been readily available.

In addition to its nutrient contents, juniper cones contain volatile oils, resins, and other chemicals with irritant properties (Claus et al. 1970). Cooking ameliorates the taste of juniper cones by driving off many of the unpleasant compounds. Another cultural adaptation for reducing the effects of irritants has been recorded for the Southern Paiute (Kelly 1964) who sample different trees until they find ones with the sweetest taste, i.e., with lower irritant contents. Similar methods would have allowed the prehistoric inhabitants of Salmon Ruin to have exploited the juniper cone crop with fewer ill-effects.

The agricultural subsistence base of the prehistoric inhabitants of Salmon Ruin probably was precarious. However, the drought-resistant juniper crop was always available, even during lean years. In addition to the ceremonial uses of juniper cones and seeds, the prehistoric inhabitants of Salmon Ruin could rely on nutrients in abundance from the surrounding juniper woodland.

ACKNOWLEDGEMENTS

This paper is based on a master's thesis completed at Eastern New Mexico University, with Dr. Vorsila L. Bohrer as chairperson. I wish to thank her, as well as Ms. Karen R. Adams, Dr. Robert R. Haynes, Dr. C. Earle Smith, Jr., and Ms. Vicki L. Young for their editorial comments. Also, I would like to thank Dr. Cynthia Irwin-Williams for providing funds; Ms. Jo Smith, San Juan County Archaeological Research Center, Salmon Ruin, for lending juniper macrofossils; and Dr. Mercedes D. Hoskins, New Mexico State University, who determined the caloric values for Salmon Ruin area juniper strobiles.

LITERATURE CITED

BASSO, H.K. 1969. Western Apache witchcraft. Univ. Arizona Press, Tucson.

BOHRER, V.L. 1980. Part 7: Salmon Ruin ethnobotanical report. Pp. 163-535, *in* Investigation at the Salmon site; the structure of Chacoan society in the northern Southwest. Final report of funding agencies, (C. Irwin-Williams and P.H. Shelley, eds.). Unpubl. Ms. on file, Golden Library, Eastern New Mexico Univ., Portales.

———, and K. ADAMS. 1977. Ethnobotanical techniques and approaches at Salmon Ruin, New Mexico. Eastern New Mexico Univ. Contr. Anthropol. 8(1), Portales.

CASTETTER, B.E 1935. Ethnobiological studies in the American Southwest: uncultivated native plants used as sources of food. Univ. New Mexico Bull. No. 266, Bio. Ser. 4:1-62.

CHAMBERLIN, R.V. 1911. The ethnobotany of the Gosiute Indians of Utah. Mem. Amer. Anthropol. Assoc. 2(5).

CLAUS, E.P., V.E. TYLER, and L.R. BRADY. 1970. Pharmacognosy, 6th ed. Lea and Febiger, Philadelphia.

COOK, S.L. 1930. The ethnobotany of the Jemez Indians. Unpubl. M.A. thesis, Univ. New Mexico, Albuquerque.

DAUBENMIRE, R.F. 1943. Vegetational zonation in the Rocky Mountains. Bot. Rev. 9(6):325-393.

DOEBLEY, J.F. 1981. Plant remains recovered by flotation from trash at Salmon Ruin, New Mexico. The Kiva 46(3):169-187.

ELMORE, F.H. 1944. Ethnobotany of the Navajo. Univ. New Mexico Monogr. Ser. 1:1-136.

FORD, R.I. 1968. An ecological analysis involving the population of San Juan

LITERATURE CITED (continued)

Pueblo, New Mexico. Unpubl. Ph.D. dissert., Univ. Michigan, Ann Arbor.

GALLAGHER, M.V. 1977. Contemporary ethnobotany among the Apache of the Clarksdale, Arizona area, Coconino and Prescott National Forests. Archaeol. Rep. No. 14, USDA Forest Service, Southwestern Region, Albuquerque.

GIFFORD, E.W. 1940. Culture element distributions: XII Apache-Pueblo. Univ. California Publ. Anthropol. Rec. 4:1-207.

GOODWIN, G. 1942. The social organization of the western Apache. Univ. Chicago Press, Chicago.

HOUGH, V.A. 1931. The bibliography of the ethnobiology of the Southwest Indians. Unpubl. M.A. thesis, Univ. New Mexico, Albuquerque.

HOWELL, J., Jr. 1941. Pinon and juniper woodlands of the Southwest. J. Forest. 39:342-345.

HRDLICKA, A. 1908. Physiological and medical observation among the Indians of the southwestern United States and northern New Mexico. Bur. Amer. Ethnol. Bull. 34, Washington, D.C.

IRWIN-WILLIAMS, C. 1977. Investigations at the Salmon site: the structure of Chacoan Society in the northern Southwest. Unpubl. res. proposal submitted to the Natl. Sci. Found.

JONES, V. 1931. The ethnobotany of the Isleta Indians. Unpubl. M.A. thesis, Univ. New Mexico, Albuquerque.

KEARNEY, T.H. and R.H. PEEBLES. 1951. Arizona flora. Univ. California Press, Berkeley.

KELLY, I.T. 1964. Southern Paiute ethnography. Anthropol. Pap. No. 69. Univ. Utah, Salt Lake City.

LENTZ, D.L. 1979. The distribution patterns and fruit productivity of modern junipers growing in the Salmon Ruin area and the archaeological interpretation of juniper seeds and cones found in Salmon Ruin, New Mexico. Unpubl. M.A. thesis, Eastern New Mexico Univ., Portales.

LITTLE, E.L., Jr. 1950. Southwestern trees. USDA Forest Serv. Agric. Handb. No. 9. Washington, D.C.

PALMER, E. 1871. Food products of the North American Indians. USDA Rep. Commiss. Agric., 1870, pp. 404-428, Washington, D.C.

PARSONS, E.C. Pueblo Indian religion, vol. 1. Univ. Chicago Press, Chicago.

RANDLES, Q. 1949. Pinyon-juniper in the Southwest. USDA Yearb. Agric., pp. 342-347, Washington, D.C.

REAGAN, A.B. 1929. Plants used by the White Mountain Apache Indians of Arizona. Wisconsin Archaeol. 8:143-161.

ROBBINS, W., J.P. HARRINGTON, and B. FREIRE-MANECO. 1916. Ethnobotany of the Tewa. Bur. Amer. Ethnol. Bull. 34, Washington, D.C.

SOKOL, R.R. and F.J. ROHLF. 1969. Biometry. Freeman, San Francisco.

SWANK, G.R. 1932. The ethnobotany of the Acoma and Laguna Indians. Unpubl. M.S. thesis, Univ. New Mexico, Albuquerque.

U.S. DEPARTMENT OF COMMERCE, NOAA, ENVIRONMENTAL DATA SERVICE. 1976. Climatological data: annual summary, New Mexico 80(13). Natl. Climatic Center, Asheville, North Carolina.

____________. 1977. Climatological data: annual summary, New Mexico 81(13). Natl. Climatic Center, Asheville, North Carolina.

VESTAL, P.A. 1952. Ethnobotany of the Ramah Navajo. Peabody Mus. Archaeol. and Ethnol. Vol. 30. Harvard Univ., Cambridge, Massachusetts.

VIVIAN, G. and P. REITER. 1965. The great Kivas of Chaco Canyon and their relationships. School of Amer. Res. Monogr. No. 22, Santa Fe, New Mexico.

WHITE, L.A. 1945. Notes on the ethnobotany of the Keres. Pap. Michigan Acad. Sci. 30: 557-568.

WHITING, A.F. 1939. Ethnobotany of the Hopi. Mus. N. Arizona, No. 15, Flagstaff.

WOODBURY, A.M. 1947. Distribution of pigmy conifers in Utah and northeastern Arizona. Ecology 28:113-126.

YANOVSKY, E. and R.M. KINGSBURY. 1938. Analysis of some Indian food plants. Assoc. Analyt. Chem. J. 21:648-655.

ZARN, M. 1977. Ecological characteristics of pinyon-juniper woodlands in the Colorado Plateau: a literature survey. USDI-BLM Tech. Note No. 510. Denver, Colorado.

RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS

JOSEPH E. LAFERRIERE
Department of Ecology and Evolutionary Biology
University of Arizona
Tucson, AZ 85721

This bibliography will update and expand a listing published in this journal a year ago (Hays 1983). That compilation gave anthropological dissertations from series A of Dissertation Abstracts (D.A.) volume 41 (1981) through volume 43 (June 1983). The present listing covers volume 44, number 1 (July 1983) through volume 45, number 3 (September 1984), selected dissertations from series B (Science and Engineering) volume 41, number 7 (January 1981), through volume 45, number 3 (September 1984), and series C (European dissertations) volume 41, number 1 (Autumn 1980) through volume 45, number 3 (Fall 1984).

As with the earlier work, this compilation was made by scanning the titles and abstracts published in D.A. and making a subjective decision as to those which might be of interest to ethnobiologists. In certain cases, dissertations appeared to be of only peripheral interest, or only part of the dissertation seemed relevant to ethnobiology; an attempt was made to be as inclusive as possible thus allowing the reader to decide for him- or herself. Since only those dissertations categorized under "Anthropology" in series A and C, and those listed under "ethnobiology," "ethnobotany," etc., in the indices of series B were considered, other relevant dissertations in other sections probably were overlooked. The compiler would be grateful for comments.

The dissertations are listed below alphabetically by author, along with the author's name, year of acceptance, title, institution, length, number of the page on which the abstract may be found, University Microfilms order number, and the ISBN number, when given.

Dissertations accepted at institutions in the United States may be obtained from University Microfilm International (UMI), P.O. Box 1764, An Arbor, MI 48106, either on microfilm or published by microfilm xerography. Quality of printed material is generally excellent, but that of photographs and tables varies depending on the quality of the original. Current pricing information may be obtained by calling 313-761-4700 or 800-521-3042 (in Canada, 800-268-6090).

Canadian and European dissertations are not now available through UMI, although this may change in the future. Relatively few European universities participate in the D.A. abstracting service; hence those listed represent a small percentage of the total. Abstracts of all the dissertations listed below are, however, published in English in Dissertation Abstracts.

ALCORN, JANIS BRISTOL (1982) Dynamics of Huastec ethnobotany: resources, resource perception, and resource management in Teenek Tsabaal, Mexico. University of Texas at Austin, 1009 pp. Diss. Abstr. 43(12); 3827-B, order no. DA8309108.

ARMSTRONG, DOUGLAS V. (1983) The "Old Village" at Drax Hall Plantation: an archeological examination of an Afro-Jamaican settlement. University of California at Berkeley, 449 pp. Diss. Abstr. 44(5):1499-A, order no. DA8321953.

BALEE, WILLIAM LOCKERT (1984) The persistence of Ka'apor culture. Columbia University, 302 pp. Diss. Abstr. 45(3):877-A, order no. DA8412964.

BEACH, H. S. (1981) Reindeer-herd management in transition: the case of Tuorpon Saameby in northern Sweden. Uppsala Universitet, Sweden, 542 pp. Diss. Abstr. 43(1):14-C, ISBN 91-554-1105-3. Published in Acta Universitatis Uppsaliensis, Cultural Anthropology, 3.

BEHRENS, CLIFFORD ALLEN (1984) Shipibo ecology and economy: a mathematical approach to understanding human adaptation. University of California at Los Angeles, 460 pp. Diss. Abstr. 45(2):564-A, order no. DA8411842.

BENDER, SUSAN JEAN (1983) Hunter-gatherer subsistence and settlement in a mountainous environment: the prehistory of the northern Tetons. State University of New York at Albany, 249 pp. Diss. Abstr. 44(12):3731-A, order no. DA8403856.

BIRGE, DARICE ELIZABETH (1982) Sacred groves in the ancient Greek world. University of California at Berkeley, 645 pp. Diss. Abstr. 44(1):205-A, order no. DA8312758.

BRETTING, PETER KONRAD (1981) A systematic and ethnobotanical survey of *Proboscidea* and allied genera of the Martyniaceae. Indiana University, 339 pp. Diss. Abstr. 42(5):1731-B, no. 8119042.

BROWN, ROY BERNARD (1984) The paleoecology of the northern frontier of Mesoamerica. University of Arizona, 204 pp. Diss. Abstr. 45(2):562-A, order no. DA 8412658.

BRUSSEL, DAVID ERIC (1981) The ethnobotany of Montserrat, British West Indies. Southern Illinois University, 181 pp. Diss. Abstr. 43(7):2093-B, order no. DA 8229243.

BUCKLEY, JOHN STUART (1983) The feeding behavior, social behavior, and ecology of the white-faced monkey, *Cebus capucinus,* at Trujillo, northern Honduras. University of Texas at Austin, 233 pp. Diss. Abstr. 44(4):1143-A, order no. DA8319568.

BUNN, HENRY THOMAS III (1982) Meat-eating and human evolution: studies on the diet and subsistence patterns of Plio-Pleistocene hominids in East Africa. 44(1):206-A, order no. DA8312768.

BURNS, BARNEY TILLMAN (1983) Simulated Anasazi storage behavior using crop yields reconstructed from tree rings: A.D. 652-1968. University of Arizona, 756 pp. Diss. Abstr. 44(1):206-A, order no. DA8311405.

CHASE, PHILIP GRATON (1983) The use of animal resources in the Mousterian of Combe Grenal, France. University of Arizona, 335 pp. Diss. Abstr. 44(3):800-A, order no. DA8315277.

CHATTERS, JAMES CARL (1982) Evolutionary human paleoecology: climatic change and human adaptation in the Pahsimeroi Valley, Idaho, 2500 B.P. to the present. University of Washington, 478 pp. Diss. Abstr. 44(1):206-A, order no. DA8308604.

CRIDLEBAUGH, PATRICIA A. (1984) American Indian and Euro-American impact upon Holocene vegetation in the Lower Little Tennessee River Valley, East Tennessee. University of Tennessee, 238 pp. Diss. Abstr. 45(2):562-A, order no. DA8411085.

DAHAL, DILLI RAM (1983) Poverty or plenty: innovative responses to population pressure in an eastern Nepalese hill community. University of Hawaii, 375 pp. Diss. Abstr. 44(6):1850-A, order no. DA8319822.

EL MAHI, A.T. (1981) Fauna, ecology, and socio-economic conditions in the Khartoum Nile environment. Universitet i Bergen, Norway. Diss. Abstr. 44(3):478-C.

FARRIS, GLEN JOSEPH (1982) Aboriginal use of pine nuts in California: an ethnological, nutritional, and archaeological investigation into the uses of the seeds of *Pinus lambertiana* Dougl. and *Pinus sabiniana* Dougl. by the Indians of northern California. University of California at Davis, 177 pp. Diss. Abstr. 44(1):206-A, order no. DA831944.

FLOWERS, NANCY MAY (1983) Forager-farmers: the Xavante Indians of central Brazil. City University of New York, 403 pp. Diss. Abstr. 44(1):211-A, order no. DA8312344.

GANJANAPAN, ANAN (1984) The partial commercialization of rice production in northern Thailand (1900-1981). Cornell University, 569 pp. Diss. Abstr. 44(12): 3732-A, order no. DA8407412.

GERBER, P. (1975) Die Peyote-Religion nordamerikanisher Indianer. (The Peyote religion of North American Indians). Universität Zürich, Switzerland, 281 pp. Diss. Abstr. 41(4):701-C.

GILL, STEVEN JEFFREY (1983) Ethnobotany of the Makah and Ozette people, Olympic Peninsula, Washington (USA). Washington State University, 454 pp. Diss. Abstr. 44(11):3286-B, order no. DA8404587.

GITTINS, GAYLE O. (1984) Radiocarbon chronometry and archeological thought. University of California at Los Angeles, 295 pp. Diss. Abstr. 45(2):563-A, order no. DA8411867.

GUTIERREZ, CHARLOTTE PAIGE (1983) Foodways and Cajun identity. University of North Carolina at Chapel Hill, 354 pp. Diss. Abstr. 44(4):1140-A, order no. DA8326612.

HALL, MATTHEW CLYDE (1983) Late Holocene hunter-gatherers and volcanism in the Long Valley-Mono Basin region: prehistoric culture change in the eastern Sierra Nevada. University of California at Riverside, 268 pp. Diss. 44(7):2182-A, order no. DA8324903.

HAM, LEONARD CHARLES (1983) Seasonality, shell midden layers, and Coast Salish subsistence activities at the Crescent Beach site, DgRr1. University of British Columbia, Canada. Diss. Abstr. 44(5):1501-A.

HASELWANDER, C. (n.d.) Die heilpflanzen und ihre verwendung in der volksmedizin des oberen feistritztales (sic.) (Medicinal herbs and their use in popular medicine of the upper Feistritz Valley.) Universität Graz, Austria, 176 pp. Diss. Abstr. 45(2):326-C.

HASTORF, CHRISTINE ANN (1983) Prehistoric agricultural intensification and political development in the Juaja region of central Peru. University of California at Los Angeles, 395 pp. Diss. Abstr. 44(2):523-A, order no. 8314655.

HEDLUND, ANN LANE (1983) Contemporary Navajo weaving: an ethnography of a native craft. University of Colorado at Boulder, 386 pp. Diss. Abstr. 44(8):2813-A, order no. DA8400903.

HEWITT, JOHN S. (1983) Optimal foraging models for the Lower Illinois River Valley. Northwestern University, 531 pp. Diss. Abstr. 44(3):801-A, order no. DA8315936.

HILL, KIM RONALD (1983) Adult male subsistence strategies among Ache hunter-gatherers of eastern Paraguay. University of Utah, 251 pp. Diss. Abstr. 44(10): 3106-A, order no. DA8402163.

HITCHCOCK, ROBERT KARL (1982) The ethnoarchaeology of sedentism: mobility strategies and site structure among foraging and food producing populations in the eastern Kalahari Desert, Botswana. University of New Mexico, 423 pp. Diss. Abstr. 44(2):523-A, order no. DA8313995.

HOLMES, CHARLES EDGAR (1984) The prehistory of the Lake Minchumina region: an archeological analysis. Washington State University, 352 pp. Diss. Abstr. 45(3): 876-A, order no. DA8413879.

HOUSTON, MARGARET SNOW (1983) The paleoethnobotany of Oaxaca, Mexico. University of North Carolina at Chapel Hill, 296 pp. Diss. Abstr. 44(4):1137-A, order no. DA8316617.

HUELSBECK, DAVID RICHARD (1983) Mammals and fish in the subsistence economy of Ozette. Washington State University, 183 pp. Diss. Abstr. 44(7):2183-A, order no. DA8325471.

JANETSKI, JOEL CLIFFORD (1983) The Western Ute of Utah Valley: an ethnohistorical model of lakeside adaptation. University of Utah, 132 pp. Diss. Abstr. 44(10):3103-A, order no. DA8401791.

KAPLAN, HILLARD (1983) The evolution of food sharing among adult conspecifics: research with the Ache hunter-gatherers of eastern Paraguay. University of Utah, 166 pp. Diss. Abstr. 44(10):3106-A, order no. DA8403986.

KATZ, SUSANNA ROTHSTEIN (1983) Late prehistoric period environment and economy of the southern Guadalupe Mountains, Texas. University of Kansas, 267 pp. Diss. Abstr. 44(4):1137-A, order no. DA8317894.

KENOYER, JONATHAN MARK (1983) Shell working industries of the Indus civilization: an archaeological and ethnographic perspective. University of California at Berkeley, 478 pp. Diss. Abstr. 45(3):876-A, order no. DA8413450.

KVAMME, KENNETH LEROY (1983) New methods for investigating the environmental basis of prehistoric site locations. University of California at Santa Barbara, 194 pp. Diss. Abstr. 44(10):3104-A, order no. DA8401747.

LITZINGER, WILLIAM JOSEPH (1983) The ethnobiology of alcoholic beverage production by the Lacandon, Tarahumara, and other aboriginal Mesoamerican peoples. University of Colorado at Boulder, 193 pp. Diss. Abstr. 45(1):39-B, order no. DA8408053.

McCORKLE, CONSTANCE MARIE (1983) Meat and potatoes: animal management and the agropastoral dialectic in an indigenous Andean community with implications for development. Stanford University. Diss. Abstr. 44(5):1506-A, order no. DA 8320743.

McKEAN, MARGARET BERNARD (1983) The palynology of Balakot, a pre-Harappan and Harappan Age site in Las Bela, Pakistan. Southern Methodist University, 508 pp. Diss. Abstr. 45(1):226-A, order no. DA8408244.

McMANAMON, FRANCIS PATRICK (1984) Prehistoric cultural adaptations on Cape Cod: ecological niches, adaptive states and temporal variation. State University of New York at Binghampton, 401 pp. Diss. Abstr. 45(1):226-A, order no. DA8408391.

MERREY, DOUGLAS JAMES (1983) Irrigation, poverty, and social change in a village of Pakistani Punjab: an historical and cultural ecological analysis. University of Pennsylvania, 896 pp. Diss. Abstr. 44(3):803-A, order no. DA8316063.

MINOR, RICK (1983) Aboriginal settlement and subsistence at the mouth of the Columbia River. University of Oregon, 253 pp. Diss. Abstr. 44(7):2183-A, order no. DA8325288.

MUNRO, M.A.R. (1982) Pollen analysis and prehistoric land use in Denmark. Queen's University of Belfast, U.K., 133 pp. Diss. Abstr. 44(3):478-C.

NABHAN, GARY PAUL (1983) Papago fields: arid lands ethnobotany and agricultural ecology. University of Arizona, 246 pp. Diss. Abstr. 44(10):2984-B, order no. DA8401271.

NESPOR, ROBERT PASCHAL (1984) The evolution of the agricultural settlement pattern of the Southern Cheyenne Indians in western Oklahoma, 1876-1930. University of Oklahoma, 470 pp. Diss. Abstr. 45(3):881-A, order no. DA8413984.

NIENU, VIKUOSA (1983) The prehistoric archaeology and human ecology of Nagaland. University of California at Berkeley, 396 pp. Diss. Abstr. 45(3):876-A, order no. DA8413537.

PENNANEN, J.M.S. (1979) Muikkaupajilla: Puruveden ammattimainen talvinuottakalastus 1900-luvun alusta 1970-luvun puolivaliin (Professional winter seine fishing on Lake Puruvesi from 1900 to the 1970's). Helsingin Yliopisto, Finland, 343 pp. Diss. Abstr. 41(1):24-C, ISBN 951-9056-35-1.

PIPERNO, DOLORES RITA (1983) The application of phytolith analysis to the reconstruction of plant subsistence and environments in prehistoric Panama (volumes I and II). Temple University, 475 pp. Diss. Abstr. 44(6):1847-A, order no. DA8321315.

PRECOURT, PRUDENCE SANDRA (1983) Settlements, systems, and patterns: an ecological systems analysis of settlement systems near Amozoc de Mota, Puebla, Mexico. University of Wisconsin-Milwaukee, 674 pp. Diss. Abstr. 45(1):226-A, order no. DA8409363.

PRUMMEL, W. (1980) Vroegmiddeleeuws Dorestad, een archaeozoölogische studie

(Early Midaeval Dorestad, an archaeozoological study). Rijksuniversiteit te Groningen, Netherlands, 600 pp. Published in English, 1982. Diss. Abstr. 43(2):213-C.

RUSSELL, SCOTT CHRISTIAN (1983) Factors affecting agricultural production in a western Navajo community. Arizona State University, 542 pp. Diss. Abstr. 44(3): 804-A, order no. 8315823.

SALEEBY, BECKY MARGARET (1983) Prehistoric settlement patterns in the Portland Basin of the Lower Columbia River: ethnohistoric, archaeological, and biogeographic perspectives. University of Oregon, 301 pp. Diss. Abstr. 44(3):801-A, order no. DA8315753.

SANFORD, PATRICIA RUTH (1983) An analysis of megascopic plant remains and pollen from Dirty Shame Rockshelter, southeastern Oregon. University of Oregon, 288 pp. Diss. Abstr. 44(7):2184-A, order no. DA8325300.

SCHNEEWEISS, E. (1979) Die Weberei der Navajos: ein Beitrag zur Geschichte eines Kunsthandwerkes im Spiegel externer Einflüsse (Navajo weaving: a contribution to the history of a tribal craft as a reflection of external influences). Universität Wien, Austria, 522 pp. Diss. Abstr. 44(3):480-C.

SCOTT, COLIN HARTLEY (1983) The semiotics of material life among Wemindji Cree hunters. McGill University, Canada. Diss. Abstr. 44(5):1507-A.

SMITH, BENNETT HOLLY (1983) Dental attrition in hunter-gatherers and agriculturalists. University of Michigan, 298 pp. Diss. Abstr. 44(2):529-A, order no. DA8314358.

STROBL, I. (1983) Subsistenz versus Cash Crops – Eine empirische Studie zu Tradition und Wandel in der Wirtschaft des Stammes der Gusii (Subsistence versus cash crops–an empirical study of tradition and social change in the economics of the Gusii tribe). Universität Wien, Austria, 277 pp. Diss. Abstr. 45(3):649-C.

SURMAN, GEORGE RIDHARD (1983) Ethnomedicine and process: strategies of treatment in a Karnataka village. University of California at Riverside, 310 pp. Diss. Abstr. 44(6):1853-A, order no. DA8323445.

THELER, JAMES LOUIS (1983) Woodland tradition economic strategies: animal resource utilization in southwestern Wisconsin and northeastern Iowa. University of Wisconsin-Madison, 451 pp. Diss. Abstr. 44(7):2186-A, order no. DA8319545.

VON LINDE, A.B. (1979) Människen, Vetet, och Kornet: Studier kring odlingens begynnelse–arkeologi och genetik (Man, wheat, and barley: studies on the beginning of cultivation and domestication–genetics in archaeology). Lunds Universitet, Sweden, 137 pp. Diss. Abstr. 41(2):701-C.

WARREN, ROBERT EDWARD (1983) Late-Holocene archeofaunal variation in Ozark Highland caves and rockshelters: environmental correlates and foraging behavior. University of Missouri-Columbia, 272 pp. Diss. Abstr. 44(12):3734-A, order no. DA8406253.

WEBSTER, GARY STEWART (1983) Northern Iroquoian hunting: an optimization approach. Pennsylvania State University, 502 pp. Diss. Abstr. 44(1):209-A, order no. DA8312679.

WEINER, MICHAEL ALAN (1978) Nutritional ethnomedicine in Fiji. University of California at Berkeley, 191 pp. Diss. Abstr. 41(12):4468-B, order no. 8111883.

WELLS, HELEN FAIRMAN (1983) Historic and prehistoric pinyon exploitation in the Grass Valley region, central Nevada: a case study in cultural continuity and change. University of California at Riverside, 231 pp. Diss. Abstr. 44(12):3734-A, order no. DA8405552.

WENDORF, MICHAEL ANDREW (1982) Prehistoric manifestations of fire and the fire areas of Santa Rosa Island, California. University of California at Berkeley, 210 pp. Diss. Abstr. 44(1):209-A, order no. 8313014.

WHITE, JAMES MURRAY (1983) Late Quaternary geochronology and palaeoecology of the Upper Peace River District, Canada. Simon Fraser University, Canada. Diss. Abstr. 44(8):2508-A.

WILLIAMS, JOHN MARK (1983) The Joe Bell site: seventeenth century lifeways on the Ocona River. University of Georgia. Diss. Abstr. 44(2):523-A, order no. DA 8314752.

WILSON, JACK HUBERT, JR. (1983) A study of the Late Prehistoric, Protohistoric, and Historic Indians of the Carolina and Virginia Piedmont: structure, process, and ecology. University of North Carolina at Chapel Hill, 666 pp. Diss. Abstr. 44(12): 3734-A, order no. DA8406956.

REFERENCE CITED

HAYS, TERENCE E. (1983) Recent anthropology doctoral dissertations of interest to ethnobiologists I. Journal of Ethnobiology 3(2):179-184.

Book Review

Desert Resources and Technology, Vol. 1. Alam Singh, Ed. Jointly published Scientific Publishers and Geotech-Academia, Jodhpur, India: 1983. Pp. 368, figs. and tables. $60.00.

A vast country, India has such a diversity of ecological areas that to gather together notes on the wide range of dryland resources and technology of such an area is in itself a formidable task. It has been well done in this first volume—so well that we are left anxiously awaiting a second contribution.

The volume is divided into eight chapters, contributed by 13 scientists, almost all Indian: 1) Fauna of the Indian desert; 2) Water reclamation for potable use; 3) Desalinization of water; 4) Unsaturated flow in an arid environment; 5) Solar and wind energies; 6) Ravine lands—reclamation and use; 7) Pasture development; 8) Economic and medicinal plants of Indian deserts. Each chapter has a specific bibliography, usually very inclusive.

The contributions are, naturally, of varying excellence, but all offer vital material not hitherto available or easily obtainable. This book will be of interest to all environmentalists working in xeric areas in any part of the world, and the eighth chapter is of significance especially to economic botanists.

Richard Evans Schultes
Botanical Museum
Harvard University
Cambridge, Massachusetts

NEWS AND COMMENTS

Keep those cards and letter coming! The value of this feature depends entirely on your willingness to take a moment to share with us an item of interest: for example, research projects planned or underway; newsworthy events, opportunities, or commentary; requests for information or assistance. Thanks in advance.

This "Shoe" cartoon seems to indicate that Mr. Jeff MacNelly is privy to current debates about folk biological classification.

Thanks to Ms. Claudia Konker, Department of Anthropology, University of Washington for the clipping. Reprinted by permission: Tribune Media Services, Inc.

HAWK'S GENES IN SHEEP'S CLOTHING

Dr. William Sturtevant of the Smithsonian Institution sent in this piece on biotechnological brinksmanship, abstracted from a *Washington Post* article on 1 October 1984 under Christine Russell's byline.

The USDA is conducting research to produce extra-large SHEEP and pigs via genetic engineering using a human growth-hormone GENE. However, Dr. Harold HAWK, chief of the USDA animal reproduction lab, noting that, "some people would be disturbed about eating human genes," plans to switch from human gene implants to using cattle genes.

But microcannibalism is not the only spectre raised by this potential blurring of the folk taxonomy. The Humane Society of the United States joined with Jeremy Rifkin's Foundation on Economic Trends to file a suit in federal district court to stop the experiments on the grounds that the research represents a "new and insidious form of cruelty toward animals," to wit, "by robbing them of their unique genetic makeup." Michael W. FOX, Scientific Director of the Humane Society—ironically allied in this case with SHEEP against HAWK—asserts that such gene transfers violate "the moral and ethical canons of civilization."

Rifkin told Judy Mann (*Washington Post* 3 October) that "every species has a certain integrity to it. In the long run, you undermine the biological basis of that species . . . Where do you draw the line? . . . There are no species boundaries anymore. That's what the public hasn't grasped." Fox adds that, "We cannot improve upon nature until we learn to work with her." Their suit asks that the experiments be "declared unlawful as a federal common law nuisance and a violation of the National Environmental Policy Act, the Administrative Procedures Act, and other statutes."

Rifkin and Fox clearly stand on the nature side of the nature-culture dichotomy. However, Sturtevant notes, their distress may also reflect discomfort at this crossing of the boundary between a "higher animal" and a human being, with appeals to a cultural form that might be seen as farthest from that sacred boundary, American civilized values. Right on, Mary Douglas, Right on!

RETROBREEDING THE WOOLLY MAMMOTH

In this regard, an item posted on my colleague Kate Mills' office door caught my eye. It had been clipped from the April 1984 issue of *Technology Review*, with the above headline. It was there reported that a Russian-American cooperative effort had succeeded in implanting a woolly mammoth ovum—retrieved from a Pleistocene ice remnant in Siberia and fertilized by sperm from a modern elephant—in the uterus of a receptive Indian elephant. The resulting offspring were said to resemble both parents, but to have retained the infantile hair. The two surviving two-year old "Mammont=elephas" individuals were last reported adapting well to the Siberian climate and in training as draft animals.

I found it astounding that this feat had not received wider coverage given its radical evolutionary implications. Dr. Mills had a good laugh at my expense, noting the publication date of April Fool's Day (byline: Diana bel-Aaron). Yet the possibility remains high on my fantasy wish list. Why not retrobreed a mammoth, a passenger pigeon, peking man?

CMRAE SUMMER INSTITUTE ON PREHISTORIC AGRICULTURE

The Center for Materials Research in Archaeology and Ethnology (CMRAE), Massachusetts Institute of Technology, announces it fourth annual Summer Institute course. This one month intensive investigation of ancient agricultural technology and its reconstruction from archaeological and paleoenvironmental data will be held 10 June – 5 July, 1985 at M.I.T. It will be taught by Frederick M. Wiseman, Principal Research Scientist, CMRAE, M.I.T. The purpose of the course is to introduce archaeologists, geographers, and scholars in related disciplines to techniques and methods used to reconstruction past agricultural technologies and crop mixes. For further information and application forms write Professor Suzanne DeAtley, Director of the summer institute, at M.I.T., Room 8-138, Cambridge, Mass. 02139, or call 617-253-1375.

MELVILLE AND ELIZABETH JACOBS RESEARCH FUND

The Melville and Elizabeth Jacobs Research Fund invites applications for small individual grants to support research on Native American cultures primarily of northwestern North America. The Fund is designed to facilitate field research rather than analysis of previously collected materials. Appropriate are field studies of any aspect of culture and society, with emphasis on expressive, conceptual, and purely linguistic systems. (Projects in archaeology, physical anthropology, urban anthropology, and applied anthropology or applied linguistics will not be funded). Awards range from $200 to approximately $800; salary cannot to supplied, and only minimum living expenses can be considered.

For further information and application forms, contact the Melville and Elizabeth Jacobs Research Fund, Whatcom Museum of History & Art, 121 Prospect St., Bellingham, Washington 98225. *Application deadline is February 15, 1985.*

SCHOOL OF AMERICAN RESEARCH SEMINAR ON AFRICA

The School of American Research, P.O. Box 2188, Santa Fe, NM 87501, plans to publish the proceedings of a conference held 22-26 October 1984 on "Early Complex Societies of Africa." This conference focussed attention on the recently unearthed urban site of Jenne-Jeno in Mali, south of the Sahara dessert. The city was founded ca 250 BC, flourished with an estimate peak population of 10,000 at 800 AD, and was abandoned by 1200 AD. Susan and Roderick McIntosh of Rice University, organizers of the conference, joined an international panel of historians and anthropologists to evaluate this earliest known sub-Saharan city.

ETHNOBOTANICAL STUDY OF AMAZONIAN ECUADOR PLANNED

The New York Botanical Garden joins the Missouri Botanical Garden in sponsoring a two-year study of the botany and utilization of plants of an area of Amazonian Ecuador. The project is being developed in collaboration with Ecuadorian academic institutions and the Ministry of Agriculture. It has the following objectives: (1) Collection and identification of plants within the study area; (2) Identification of the species by local people as food, fuel, medicine, fiber, etc.; (3) Collection of plant samples for nutritional and chamical analysis; (4) Identification of the most promising plant species for increased economic or subsistence utilization with collection of living material for cultivation and study by researchers; (5) Training of local students in field botany techniques. For more information contact Dr. Ghillean T. Prance, Director, Institute of Economic Botany, The New York Botanical Garden, Bronx, New York 10458.

8TH ANNUAL ETHNOBIOLOGY CONFERENCE

The Botanical Museum of Harvard University, the Archaeology/Anthropology Program of the Massachusetts Institute of Technology, and the Biology Department of the University of Massachusetts/Boston are co-sponsoring the 8th Annual Ethnobiology Conference. It will be held in Cambridge and Boston on Wednesday, Thursday, and Friday, May 8, 9, and 10, 1985. An announcement giving registration information, a call for papers, symposia plans, and other details will be mailed to those on the Society mailing list. For further details and/or to request an announcement, write to:

Dr. Frederick Wiseman
Archaeology/Anthropology Program
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Book Review

The Heirloom Gardener. Carolyn Jabs. San Francisco: Sierra Club Books, 1984. 288 pp. $17.95 cloth, $9.95 paper.

Every plant breeder knows the importance of maintaining a wide genetic base from which to draw new material, but few realize the extent of diversity available in obscure locations in the United States. Few lay people fully comprehend the importance of this need, nor truly appreciate the important role they have played and can continue to play in maintaining this genetic diversity. Now there is a book which fills this gap between amateur and professional, and provides valuable information to both.

In her book **The Heirloom Gardener**, Carolyn Jabs examines from numerous angles and with unsurpassable clarity and depth, the problem of the heirloom plant variety, the old traditional lines of fruits and vegetables found across the U.S. and preserved by hobbyists and backyard gardeners. She explains in terms easily understandable to the average lay person, the importance of genetic diversity and the risks of uniformity. She discusses the tendency of large seed companies to emphasize large scale field crops, and the resulting decline in the number of varieties offered by these companies over the last 100 years. She also outlines the inadequacies of existing governmental germplasm storage programs, which concentrate on imported races and wild strains at the expense of equally valuable traditional North American varieties.

She then discusses who is growing these traditional varieites today, and why they are doing so. These people include hobbyists who collect varieties of certain crops, seed sharing organizations, smaller, regional seed companies, and living history musuems which try to reconstruct gardens of pioneers or of famous figures such as Lincoln and Jefferson. She also describes how to go about obtaining seeds from such sources, and provides instructions to lay people on how to harvest and store seeds, and how to graft stock from fruit trees.

For the professional interested in doing research on these plants, the most valuable part of the book would probably be the appendices, which provide extensive annotated listings of seed companies, seed exchanges, federal seed repositories, and living historical farms and museums, as well as giving a bibliography of selected historical sources, old horticultural books, and old seed catalogs.

For the ethnobotanist, the historical depth in the book provides an enlightening picture of the social forces which have been influencing genetic diversity and crop evolution in this country for over two centuries. The book also serves to remind us that there is a tremendous potential for the study of traditional plants right here within our own culture.

It would be rather easy for a book on this kind of topic to be written in a dry, factual tone. Jabs, however, writes in a very clear, vivid style, using interesting, personalized examples, but yet relating such a wealth of information as to betray a thorough knowledge of the subject.

I have absolutely no reservations about recommending the book as a source of information for the interested backyard gardener, as a reference book for professionals, or as supplementary reading material for undergraduate courses in ethnobotany, economic botany, plant breeding, crop evolution, or even introductory botany.

Joseph E. Laferriere
Department of Ecology &
Evolutionary Biology
University of Arizona
Tucson, Arizona

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed doubled-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses*, i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Arizona State Museum
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

With Volume 3, Number 1, the editors of the *Journal of Ethnobiology* added a book review section. We welcome suggestions on books to review or actual reviews from the readership of the *Journal.* Please send suggestions, comments, or reviews to Charles H. Miksicek or Richard S. Felger, Office of Arid Lands Studies, University of Arizona, Tucson, Arizona 85721.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Steven D. Emslie, Department of Zoology, University of Florida, Gainesville, Florida 32611. Subscription rates are $35.00, institutional; $17.00 regular members, for U.S., Canada, and Mexico; foreign subscribers add $8.00. Write checks payable to *Journal of Ethnobiology.* Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

CONTENTS

Journal of Ethnobiology

VOLUME 5, NUMBER 1

SUMMER 1985

Journal Organization

Journal of Ethnobiology is published semi-annually. Manuscripts for publication and information for the "News and Comments" section should be sent to the appropriate editor as explained on the inside back cover of this issue.

ISSN 0278-0771

Journal of Ethnobiology

VOLUME 5, NUMBER 1 SUMMER 1985

SKETCHES IN THE SAND

One of the pleasures of being editor of this journal is that I enjoy a great deal of interaction with people and I have free rein in this column. I am pleased that this time there is an especially joyous event about which to write.

I am happy to extend on my behalf and that of the Editorial Board and the membership of the Society of Ethnobiology CONGRATULATIONS and wishes that are at once sincere and almost estatic over the welcome news of an honorary doctoral degree awarded this spring by The University of British Columbia, Canada, to Margaret Siwallace. Dr. Siwallace has been acknowledged in several papers published by the *Journal* and many will remember her presentation on *ooligan* grease at the Seventh Annual Ethnobiology Conference in Seattle (April, 1984).

It is gratifying to see that at least one institution of higher learning recognizes and acknowledges—so it would seem—that folk knowledge is a valuable human resource as well as being fascinating in its own right and having its own wisdom and insights. Formal recognition of Margaret Siwallace's talents, skills, devotion, and contributions to academic scholarship through work with ethnographers and ethnobiologists is both richly deserved and long overdue. I commend the scholars of the Pacific Southwest of Canada who undoubtedly nominated her for this great honor and The University of British Columbia for making the award.

It is heartwarming to note in recent years (it's about time) a shift in attitude and regard of academicians toward those wonderful fellow humans—the possessors of folk knowledge who are at once our teachers (teaching us humility, patience, and other qualities we didn't ask about), our students (learning from us qualities that, in some instances, they might better be without), our friends, and our guides. Ethnographers and especially ethnobiologists now often refer to those with whom we have such a relationship as native consultants (rather than as informants, a term prevalent in the older literature). And occasionally some of these folk teachers now participate in ethnobiological conferences as they did at the Third Annual Ethnobiology Conference in Tucson (1980) and at the ethnobiology symposium sponsored by the Congresso Brazileiro de Zoologia in Brazil last year.

Although many are mentioned in dissertations and published works, there are nonetheless others who share their folk knowledge who remain unacknowledged by the academic world. In some cases this is by choice, in others there is no easy or natural way by which acknowledgement can be made. I know of several Native North and South Americans, for example, who, from time to time, show urban school children their gardening and agricultural methods or who give demonstrations and receive little recognition for this sharing of themselves.

I feel certain that Dr. Siwallace would be delighted for the *Journal* and the Society of Ethnobiology to recognize all those who live close to tradition, Nature, and the Soil (e.g. many Native Americans, rural folks of the Appalachian and Ozark Mountains or people of Mexican heritage in the American Southwest), both in and out of embodiment, who have been or are our co-servers, co-workers and "folk colleagues" in ethnobiology. We thank each of you wherever you may be.

W.V.

J. Ethnobiol. 5(1):1-19 Summer 1985

PALEOETHNOBOTANICAL EVIDENCE FOR DEFORESTATION IN ANCIENT IRAN: A CASE STUDY OF URBAN MALYAN

NAOMI F. MILLER
Department of Anthropology
Washington University
St. Louis, MO 63130

ABSTRACT.—Plant remains from archaeological sites can provide information about the ancient environment. However, these remains should be considered archaeological artifacts, "filtered" through human culture. Adequate interpretation is only possible, and is indeed enriched, by taking the cultural practices of human populations into account. This approach is applied to archaeobotanical materials from Malyan, a fourth to second millennium B.C. site in Fars province, Iran, where there is archaeological evidence for population increase, growing complexity of settlement organization, and technological changes. Clearance of the ancient woodland in the vicinity of Malyan, and concomitant changes in the choice of fuel woods, can account for the observed changes in the proportions of woody taxa found during excavation. In particular, it appears that as the local poplar and juniper were removed, wood of the more distant oak forest was used. Deforestation was a result of a growing population's fuel demands for domestic and technological—especially metallurgical—purposes.

INTRODUCTION

Iran has had sedentary communities for about 10,000 years. The beginning of this period marks the transition to an agricultural way of life. By the fourth millennium B.C., the great urban civilizations of antiquity were developing in Mesopotamia and Iran. Human populations have therefore had both the social organization and the technology to maintain themselves at relatively high densities for thousands of years—densities great enough to result in substantial changes in the natural environment.

Changes in the prehistoric environment have been documented by archaeologists based upon settlement pattern studies (Jacobsen and Adams 1958; Gibson 1974), by the study of botanical remains from excavations (Conrad and Koeppen 1972; Willcox 1974; Helbaek 1960; Minnis 1978; cf. Western 1971), and by analysis of ancient texts (Hughes 1983; Wertime 1983).

The site of Malyan in the Zagros Mountains of southwestern Iran, about 46 km northwest of Shiraz (Figures 1, 2), lies at an elevation of about 1700 m on the northwest end of the broad, flat Kur River basin. The major Near Eastern domesticates (wheat, barley, sheep, goat and cattle) were and continue to be the basis of the agricultural economy.

Although the plain has been occupied by settled populations since the seventh millennium B.C., the major occupation of Malyan began during the Banesh period, ca. 3400-2800 B.C.[1] Population estimates of 100 to 200 people/ha of occupied settlement suggest that the Banesh population in the valley was 5650 to 11,300 (Alden 1979; Sumner 1972). Most of the people were concentrated at Malyan itself, which had a population of 4500-9000. The remainder of the population lived in villages of less than 3.5 ha. By the time Malyan reached its maximum extent during the subsequent Kaftari period (ca. 2200-1600 B.C.), the city had grown from about 45 ha to 130 ha, with total occupied settlement area in the Kur basin of 288 ha (Sumner 1972). Thus the population of Malyan was between 13,000 and 26,000, and the total settled population was about 30,000 to 60,000.[2]

In addition to regional population increase, the organization of settlement also

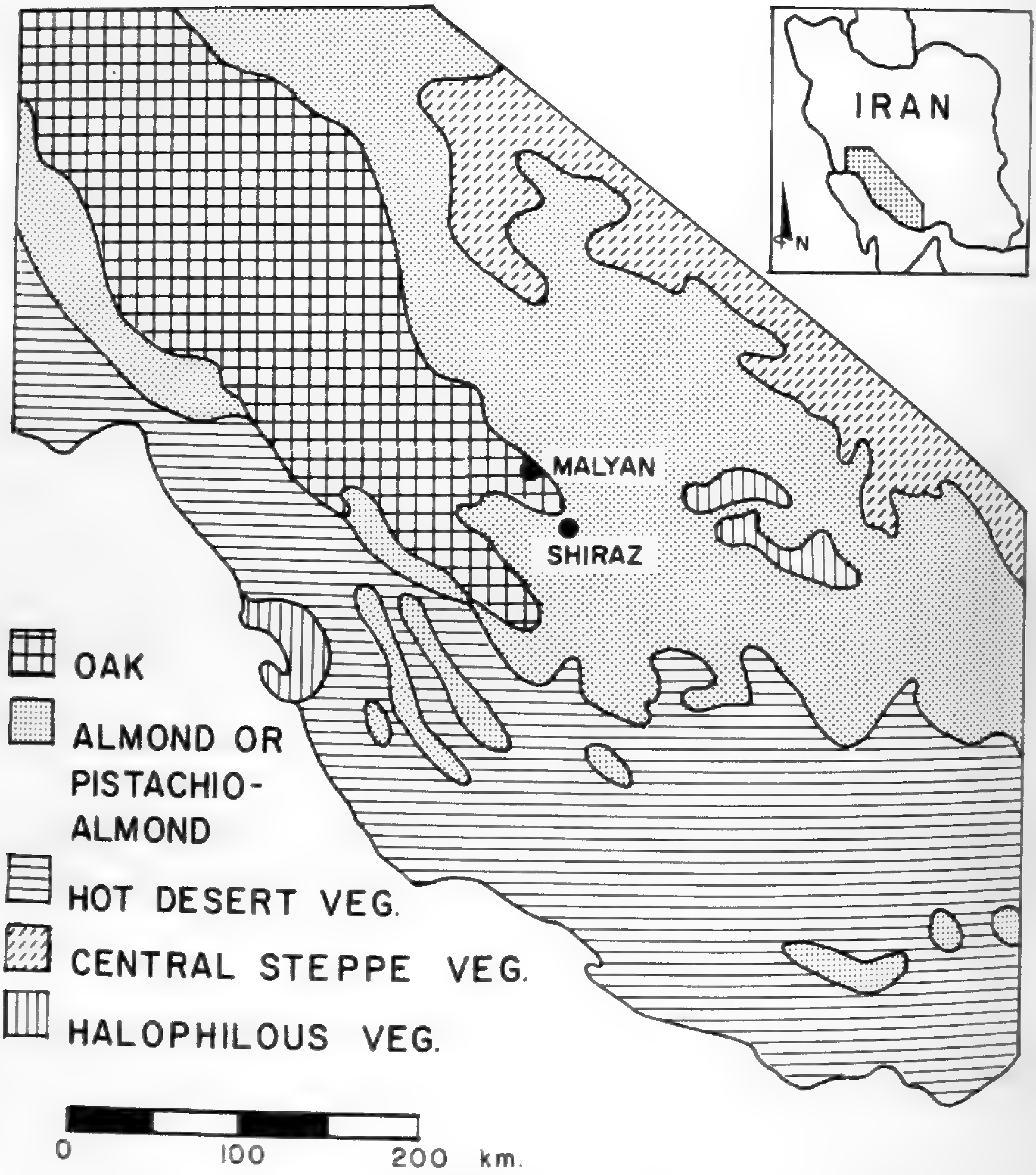


FIGURE 1.–Vegetation of southwestern Iran (after Zohary 1963).

changed. During the Kaftari period, only about one half of the population lived in Malyan, while the remainder were scattered in numerous villages and towns (0.5 ha to 10 ha) to the south and east (Sumner 1972, 1980).

Other important changes were taking place as well. Kaftari period Malyan is known in ancient texts as Anshan (Hansman 1972; Reiner 1974; Stolper 1976). Royal titles demonstrate a political link between Anshan, the highland capital of the Elamite polity, and Susa, the lowland capital during the Elamite period (Amiet 1979), roughly contemporary with the Kaftari deposits at Malyan. Malyan became increasingly involved in a broader economic and political network. A greater quantity of exotic goods is found at Malyan (Sumner 1974: 173). The third millennium saw an increase in bronze metallurgy throughout the Near East (Mallowan 1971:239-240, 305-306; cf. Lloyd 1978:82, 127; cf. Moorey 1982). At Malyan, copper-bronze slag indicative of smelting is more widesprad in the Kaftari period deposits.

The way in which a population exploits a given territory depends in part on its density, the way it is distributed over the landscape, its economic activities, and the resources available to it. These factors changed during the third millennium B.C. in the Kur basin. Excavations at Malyan provide evidence for the impact of human economic activities on the environment during the late fourth/early third and late third/early second millennia B.C. This report will show how ethnobotanical evidence can be used to monitor some of

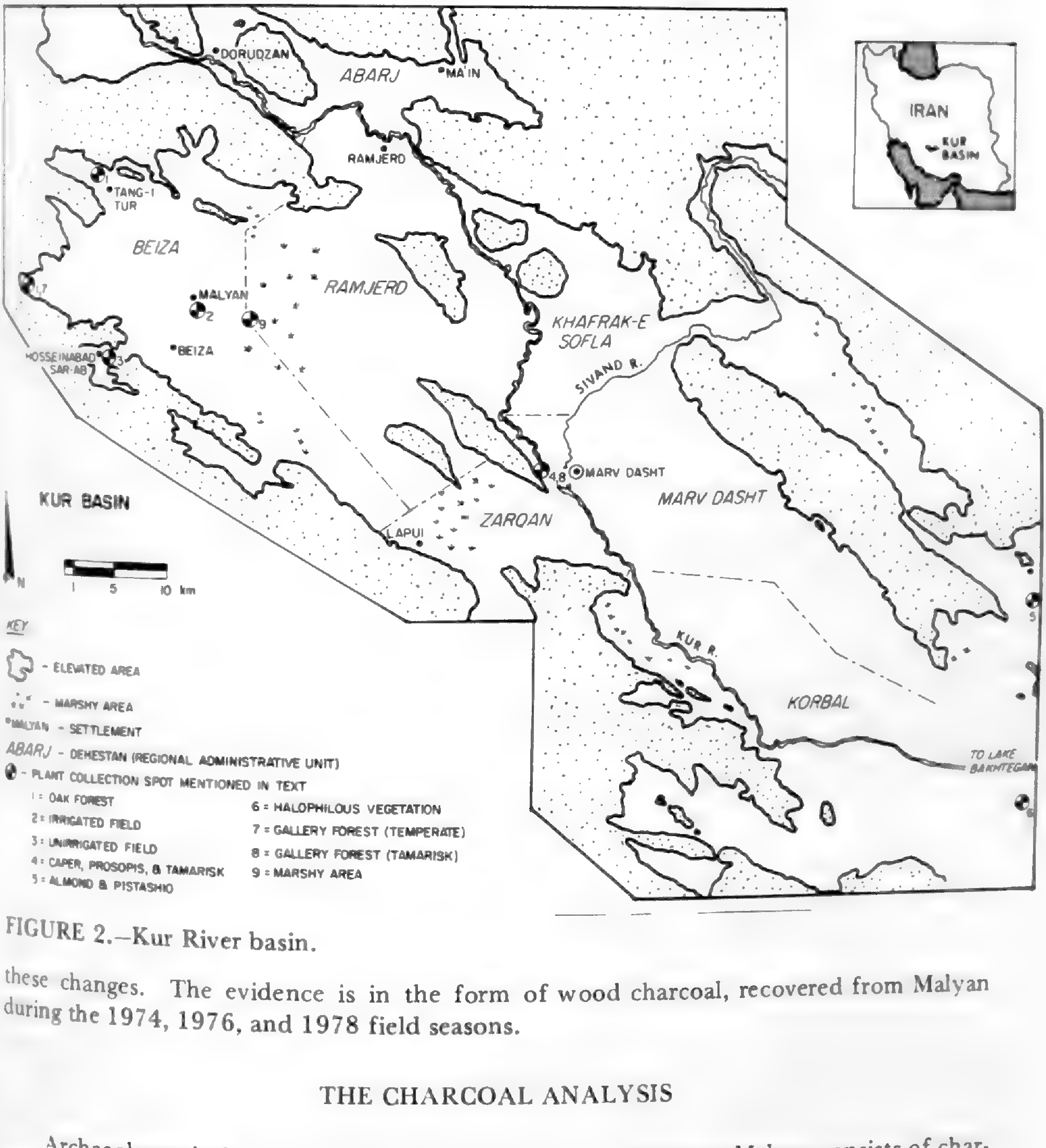


FIGURE 2.—Kur River basin.

these changes. The evidence is in the form of wood charcoal, recovered from Malyan during the 1974, 1976, and 1978 field seasons.

THE CHARCOAL ANALYSIS

Archaeobotanical evidence for the use of wood resources at Malyan consists of charcoal. Generic identifications of the charcoal were made by comparison with known, freshly carbonized woods collected during the 1976 and 1978 seasons. A variable power microscope with magnification of 7 - 30 x was used.[3] The modern comparative material was identified at the Royal Botanic Garden at Kew, England.

Charcoal pieces were broken manually so that the transverse section would be visible. With the help of Scanning Electron Microscopy (SEM) photographs of modern charred specimens (Miller 1982) and direct visual comparison with identified specimens[4], features such as the distribution of pores within the annual growth ring, ray thickness, and presence/absence of gum were noted. Fortunately, the major genera of the southern Zagros forests are anatomically distinctive relative to one another, so it was not necessary to examine each specimen at a higher magnification. Pieces with less than a complete growth ring, and those that crumbled beyond recognition were not included in the analysis; large pieces that had indeterminate anatomical features, as well as unfamiliar woods, are included in the category "unknown." Total identified pieces for each taxon in each sample were then weighed. Up to 20 pieces per excavation unit were identified when available. Although the pieces were not randomly selected, both small and large pieces were chosen. Some archaeological features were excavated in several units. Thus, more than 20 pieces of charcoal were identified from some of the larger and charcoal-rich features.

Although only 0.2% of the 130 ha site has been excavated to date, both Banesh and Kaftari deposits have been sampled extensively (Sumner 1980; Nicholas 1980; Nickerson 1983). A large number of sediment samples (ca. 10 l each) was taken for flotation (Table 1), and charcoal visible in the site matrix was collected on the site by the workmen. Some of the charcoal was submitted for radiocarbon dating and is unavailable for the paleoethnobotanical analysis. The charcoal from the Banesh and Kaftari periods at Malyan comes from a variety of residential contexts—hearths, pits, rooms, jar fill—burials, and other sediment matrix.

TABLE 1.—*Flotation sample summary from Malyan.*

Period	No. Deposits Sampled	No. liters floated	Charcoal Total Wt. (g)	Seeds Total Wt. (g)	Carb. Material
Banesh	97[1]	1303	426.49	3.11	429.60
Kaftari	89	1301	438.25	38.18	476.43

[1]Sediment volume of two jar samples could not be determined, so they are not included in this table.

The charcoal comes from two types of sample. The first consists of large pieces (generally about 1 to 3 cm in diameter) collected by hand during excavation[5]; the second consists of smaller pieces, well under 1 cm in diameter, recovered by flotation of sediment samples at the field laboratory.[6] Identification of the larger, hand-picked pieces is somewhat more certain, because it is generally easier to identify larger pieces. Also, the hand-picked pieces represent a greater quantity of wood per sample.[7]

For both time periods, information from numerous samples is combined, enabling comparison of the two. The initial justification for this step was that for both Banesh and Kaftari periods there is no evidence of burned structures. It is therefore assumed that the bulk of the charcoal represents wood or charcoal intentionally burned as fuel, regardless of whether it is found in primary hearth or secondary trashy deposits. No assumptions are made about the purpose of the fires, which could have been for cooking and other food processing, for heating, ceramic manufacture, and smelting, or for ritual activities. Some of the hearths and ovens have relatively high densities of charcoal (Miller 1982, Table B.1).

Although the amount of charcoal recovered does not necessarily reflect the amount of wood burned, one might expect charcoal weight to be the most appropriate measure of the relative importance of different taxa. The number of pieces of wood put into a fire, or the number of pieces of charcoal left when that fire is extinguished, would seem to bear a less direct relationship to the quantity of wood burned than does the amount (by weight) of charcoal left when that fire is extinguished. In addition, fragmentation rates may vary among different wood types. It is therefore intuitively appealing to measure charcoal quantities by weight to compare the relative importance of different taxa. Unfortunately, many of the small pieces from the flotation samples are too light (less than .02g) to weigh accurately. The charcoal fragments frequently have mineral or clay encrustations, further distorting the very low weights. Therefore, the use of charcoal counts is more practical.

In order to see whether an analysis by counts would differ from an analysis by weights, a correlation analysis of weights and counts for flotation and hand-picked samples was carried out. Counts and weights are highly correlated (Table 2). I have chosen to emphasize the number of charcoal pieces or count for the rest of this analysis better to compare flotation and hand-picked charcoal (Table 3). As a supplement to the

TABLE 2.–*Correlation of charcoal counts and weights of the major taxa.*

Taxon	No. Samples	Corr. coeff. (r)[1]
Juniper	29	.73
Almond	40	.80
Maple	18	.94
Pistachio	35	.81
Oak	33	.88
Poplar	19	.72
Elm family	25	.76

[1]Correlation coefficients significant at $p < .01$.

use of count and weight, relative frequency of the taxa can be used to identify types that may have a consistent but low level of occurrence (cf. Hubbard 1980). Weight and frequency measures are therefore useful checks on the data based on count (Tables 4 and 5). It is not possible to report densities for the hand-picked charcoal; although excavated volume of the various loci and features were calculated by the excavators, not all charcoal was collected. Pieces sent for radiocarbon dating were not available for this analysis.

Increase or decrease in the proportions of a taxon may be affected by a number of factors. First, because of the large size of the site, a sample of 10m x 10m squares was chosen for excavation, and not all areas were sampled equally.[8] Within the excavated areas, differences among hearths, pits, and other deposit types could conceivably account for some of the differences among samples (Table 6). Although it is inappropriate to use inferential statistics in the analysis, a representative group of deposits was sampled. Examination of a large number and variety of deposits, sampled by flotation and visual inspection, and measured in several ways (i.e., count, weight, and frequency) increases confidence that the observed patterning in the data accurately reflects the distribution of material on the site. Consistency among the various measures then provides the means to assess the reality of changes in the archaeobotanical record.

Differential distribution of charcoal within the site is assumed not to interfere with the broad comparison of taxon composition by time period because: (1) Overall charcoal densities in the flotation samples were of similar magnitude for each time period; (2) Both periods are represented by shallow and deep deposits; (3) A variety of contexts was sampled for both periods, and differences among deposit types were less pronounced than between time periods; (4) Banesh and Kaftari charcoal is assumed to have been from fuel because there are no burned structures.

CHARACTERISTICS OF THE MODERN VEGETATION

Today, the natural vegetation of the region is greatly disturbed by human activities. On the plain, lands not in cultivation are used for pasture, and the limestone hillsides surrounding the plain are largely denuded of vegetation. Reconstruction of the natural vegetation is based upon remnant forests of less populous areas. The vegetation is an open woodland. Presently forested areas are discontinuous, so boundaries between vegetation zones cannot be drawn exactly. Malyan lies at the southeastern limits of the Zagros oak forest, near the pistachio-almond steppe forest (Figure 1; Zohary 1963). Remnants of these forest types still exist in the area (Figure 2). At the northwest end of

TABLE 3.–*Charcoal counts from Malyan.*

	Hand-picked Samples				Flotation Samples			
	Banesh		Kaftari		Banesh		Kaftari	
No. of deposits (N)	(N=35)		(N=40)		(N=99)		(N=89)	
Taxon:	#	%	#	%	#	%	#	%
Dry Forest								
Juniperus excelsa[1]	243	32	45	5	118	14	4	+
Amygdalus sp.	101	13	159	17	372	43	322	30
Acer monspessulanum[1]	21	3	130	14	24	3	121	12
Almond/ Maple	–	–	1	+	–	–	–	–
Pistacia sp.	65	9	199	21	148	17	141	13
Quercus aegilops[1]	45	6	235	25	55	6	269	26
Humid								
Populus sp.	162	22	10	1	48	6	24	2
Fraxinus sp.	–	–	13	1	3	+	2	+
Platanus orientalis[1]	–	–	–	–	–	–	1	+
Vitex sp.	–	–	18	2	–	–	–	–
Distant Vegetation								
Capparis spinosa[1]	–	–	8	1	–	–	–	–
Prosopis sp.	–	–	1	+	–	–	2	+
Miscellaneous								
Vitis vinifera[1]	–	–	23	2	–	–	2	+
Daphne acuminata[1]	1	+	–	–	–	–	1	+
Rhamnus sp.	–	–	–	–	4	+	–	–
Ulmaceae	80	11	46	5	23	3	24	2
Diffuse Porous	–	–	–	–	14	2	39	4
Unknown	33	4	70	7	60	7	99	9
Totals[2]	751	100	958	101	869	101	1051	98

[1]Identifications to species are based on phytogeographic grounds, not morphology (cf. Sabeti 1966).

[2]Based on data presented in Miller (1982).

TABLE 4.—*Charcoal weights of hand-picked samples from Malyan.*

	Banesh		Kaftari	
No. of deposits (N):	(N=35)		(N=40)	
	Wt. (g.)	%	Wt. (g.)	%
Taxon:				
Juniperus excelsa	123.88	38	35.65	10
Amygdalus sp.	21.56	7	58.63	17
Acer monspessulanum	3.94	1	42.10	12
Almond/Maple	–	–	.07	+
Pistacia sp.	32.37	10	84.44	25
Quercus aegilops	14.29	4	73.37	21
Populus sp.	93.21	29	1.32	+
Fraxinus sp.	–	–	7.81	2
Vitex sp.	–	–	1.04	+
Capparis spinosa	–	–	6.19	2
Prosopis sp.	–	–	.06	+
Vitis vinifera	–	–	8.42	2
Daphne acuminata	.12	+	–	–
Ulmaceae	14.26	4	11.04	3
Diffuse Porous	4.51	1	–	–
Unknown	13.67	4	12.64	4
Total	321.81	98	343.78	98

the Kur River basin is an area of oak forest[9] which includes some pistachio. Almond grows on the lower and south-facing slopes. Several other species of trees and shrubs, such as maple and wild fig, are less common. At the southeast end of the plain is a fairly extensive stretch of somewhat degraded pistachio-almond forest. The pistachio-almond forest is more xerophytic than the oak forest, though they share some genera, such as maple. Juniper, which is present in the archaeological samples, is today fairly rare in the mountains of southwestern Iran. Bobek (1951) considers *Juniperus excelsa* "characteristic" of the transition zone between the dry southern Zagros oak forest and the pistachio-almond steppe forest of Fars province, but it is less common in the former. It grows well on calcareous soils and has an elevational altitudinal range of 1500 to 3400 m (Pabot 1960), so Malyan is near the presumed lower limit of its range. The one juniper specimen

TABLE 5.–*Frequency of charcoal.*

	Hand-picked Samples				Flotation Samples			
	Banesh		Kaftari		Banesh		Kaftari	
No. of deposits (N):	(N=35)		(N=40)		(N=99)		(N=89)	
Taxon:	#	%	#	%	#	%	#	%
Juniperus excelsa	26	65	3	9	34	34	11	12
Amygdalus sp.	21	53	17	49	57	57	58	65
Acer monspessulanum	4	10	14	40	12	12	35	39
Pistacia sp.	18	45	17	49	33	33	37	42
Quercus aegilops	9	23	24	69	19	19	55	62
Populus sp.	14	35	5	14	18	18	13	15
Fraxinus sp.	–	–	1	3	3	3	2	2
Platanus orientalis	–	–	–	–	–	–	1	1
Vitex sp.	–	–	1	3	–	–	–	–
Capparis spinosa	–	–	3	9	–	–	–	–
Prosopis sp.	–	–	1	3	–	–	1	1
Vitis vinifera	–	–	4	11	–	–	2	2
Daphne acuminata	1	3	–	–	–	–	1	1
Rhamnus sp.	–	–	–	–	2	2	–	–
Ulmaceae	16	40	9	26	13	13	11	12
Diffuse Porous	–	–	–	–	10	10	12	13
Unknown	11	27	15	43	21	21	34	38

found in the oak forest near Malyan is probably *Juniperus excelsa* M.B., a xerophytic species.

On the plain itself, most trees are cultivated, and groves typically consist of poplar (*Populus alba* L., *P. nigra* L.), willow (*Salix excelsa* G.M. Gmel.), ash (*Fraxinus syriaca* Boiss.), or fruit trees. In the central part of the plain near the city of Marv Dasht and toward the southeast, there are several species that prefer a warmer climate or that tolerate more saline conditions. Tamarisk (*Tamarix* sp.), which here grows as a shrubby tree, and caper (*Capparis spinosa* L.) and *Prosopis* (*P. farcta* L.), both shrubs, are relevant to the present discussion. They were never seen growing at the northwest end of the plain and were unfamiliar to a couple of Malyan boys with whom I visited this area.

TABLE 6.–*Density of charred material.*

	Banesh		Kaftari	
Deposit type	N	Mean	N	Mean
Fireplaces[1]	18	17.86	4	1.71
Pits	16	4.64	28	4.37
Rooms	49	1.45	32	3.18
Burials	3	2.79	–	–
Jars	4	1.33	3	1.22
Matrix[2]	7	2.64	22	4.86
Total	97[3]		89	

[1]Fireplaces: hearths, ovens

[2]Matrix: soil matrix not found in association with architecture

[3]Sediment volume of two jar samples could not be determined, so they are not included in this table.

CHARACTERISTICS OF MODERN WOOD USE

The effect of human activity on vegetation largely depends on the uses to which particular plants are put. First, wood is brought to a settlement for a variety of purposes, such as construction and fuel, and trees of both forests and gardens are cut and used differentially. Most woods are suitable as fuel, but variability in heat production, smokiness, and sparking will affect their desirability for particular tasks. Second, wood is a bulky commodity. If it is the primary fuel for cooking and heating, supplies must be replenished regularly. For example, estimates for fuel use in traditional Middle Eastern societies averaged over a year are 1.5-2 kg/person/day (Thalen 1979; Horne 1982a). Transport costs are therefore a significant factor in choice of wood (Chisholm 1967; Forest Research Institute 1972), and one would expect that, other things being equal, trees closest to home will be utilized first. Cultural preferences for particular wood resources are frequently determined by purpose and availability (e.g. Heizer 1963; Metzger and Williams 1966), which depend to some extent on the different physical and biological properties of trees. Knowledge of these properties can therefore be used to help interpret variation in the relative proportions of different species on an archaeological site.

Most of the major woods available today are suitable for fuel. Present-day villagers used to travel with donkeys and on foot to the mountains 15 or 20 km away in winter for wood; they mention almond (*Amygdalus* sp.), oak (*Quercus aegilops* L. ssp. *persica* (J. & S.) Blakelock), pistachio (*Pistacia* cf. *eurycarpa* Yalt.), and maple (*Acer monspessulanum* L.) as having been important. Poplar (*Populus alba* L. and *P. nigra* L.), grown for use as roof beams, is available in the village and sometimes is used to supplement dung-cake fuel. Juniper, found archaeologically, is quite rare nowadays.

The physical properties of these woods differ. Generally, oak burns hotter than maple and juniper (Graves 1919), although juniper[10] "is an excellent fuel and said to yield good charcoal" (Townsend and Guest 1966: 92). Pistachio, a resinous wood, may be a preferred fuel (cf. Mikesell 1961: 26). Almond is probably a good fuel wood too, but information about its burning qualities is hard to come by. Poplar is quite porous and burns rather quickly so is somewhat less desirable. Dung is also readily available for fuel, since most households own at least a few cattle, sheep, or goats. Wood, although preferred over dung cake fuel, is relatively expensive, and, at least in 1978, there were legal restrictions against fuel cutting in the forest.

The biological characteristics of the trees will affect their availability. *Juniperus excelsa*, for example, is a fairly slow-growing, xerophytic tree (Pabot 1960), and is adversely affected by a combination of fuel cutting and grazing (cf. Thalen 1979). Since it does not compete well with oak (Pabot 1960), it would not be able to renew itself if over-exploited for fuel. In contrast to juniper, poplar is fast-growing, and, when cut, readily puts up new shoots. Unlike juniper, it has a high water requirement, and in the arid climate of southwestern Iran, is restricted to stream sides, irrigated groves, and other areas with a high water table. Because it is always in demand for roof beams, it is cultivated and protected. Fuel is merely a by-product of its use in construction in the region today, and it is therefore always available, at least in small quantities.

FOREST UTILIZATION IN ANCIENT TIMES

The major genera found archaeologically at Malyan are juniper, oak, almond, pistachio, maple, and poplar. Perhaps the most striking difference between the Banesh and Kaftari levels is the inverse relationship between juniper and poplar on the one hand and oak and maple on the other (Tables 3, 4, 5). This relationship obtains regardless of analytical method (Table 7). During these time periods, almond and pistachio percentages remain fairly constant. The very small quantities of caper and *Prosopis* do not appear until the end of the sequence. In addition to these changes in the use of wood and charcoal fuel, there is indirect evidence for an increase in the use of dung fuel relative to wood and charcoal (Miller and Smart 1984).

Wood found on an archaeological site has been selected by people, so the composition of the charcoal assemblage is not directly analogous to the ancient vegetation. A change in wood use might represent a change in the relative availability of the economi-

TABLE 7.–*Consistency of results for the major wood taxa (changes between Banesh and Kaftari periods).*

Taxon	Hand-Picked			Flotation	
	Counts	Weights	Frequency	Counts	Frequency
Juniper	decline	decline	decline	decline	decline
Almond	slight increase	increase	slight increase	slight increase	slight increase
Maple	increase	increase	increase	increase	increase
Pistachio	increase	increase	slight increase	slight decline	increase
Oak	increase	increase	increase	increase	increase
Poplar	decline	decline	decline	slight decline	slight decline
Elm family	decline	slight decline	decline	slight decline	slight decline

cally important species. Changes in availability may be associated with climatic change, or, as is more likely in this case, with human interference with natural forest growth.

Before changes in wood use can be assessed, Post-Pleistocene climate and vegetation changes must first be considered. Ancient climatic conditions can be inferred from pollen analysis if suitable sediments are available for testing. Information thus obtained is complementary to ethnobotanical data from archaeological sites. Samples taken by H. E. Wright from a salt lake near Shiraz unfortunately yielded insufficient quantities of pollen to be useful for environmental reconstruction (1985, personal communication). Summarizing the available pollen evidence, Wright (1977) and van Zeist and Bottema (1982) infer that the Pleistocene environment over much of the Near East was a cold dry steppe. The species typical of the Zagros oak forest would have spread in a southeasterly direction from Syria and southeastern Turkey at the end of the Pleistocene (van Zeist and Bottema 1977). Conceivably this expansion of the oak forest in the post-glacial period did not reach the southern Zagros until the third millennium B.C., and it replaced a more xerophytic mixed forest of pistachio, almond, maple, and perhaps juniper. This reconstruction is not likely for two reasons. First, data from Lake Zeribar in the central Zagros indicate that the modern climate in that region became established by 5500 B.P. (van Zeist and Bottema 1982). Using the MASCA radiocarbon correction, this date is equivalent to about 4250 B.C. (Ralph et al. 1973), well before the Malyan samples. Second, although climate and vegetation history are important determinants of the presence, absence, or relative abundance of particular species, the proportions of different species is also influenced by people. The disjunct but widely dispersed occurrence of juniper in southern Iran today suggests that were it not for herding and fuel-cutting activities the area could support more juniper than it does at present.

Alternatively, a change in local availability of various tree species could be affected by factors other than climate. The use of wood by human populations determines which taxa will be brought to a site, and in the absence of accidental fires, which taxa will be preserved as charcoal. Wood cutting by human populations can alter the composition of the forest as well as its extent. Probable activities involving tree use are based on general and specific ethnographic analogy, and are partially corroborated by some of the archaeological evidence (Table 8). It is also possible to assess the amount of wood involved in various activities.

Fuel.–Wood may be used directly as fuel, or it may first be transformed into charcoal. Although trees may be pruned rather than felled for wood and charcoal, continuous demands for fuel by settled populations, especially in semi-arid climates, can lead to forest depletion.[11] Most structures excavated at Malyan represent domestic architecture. Given the cold winters of the Kur River basin, heating would have been necessary for part of the year. Various hearths and ovens suggest that food preparation and heating fires were set in built-in facilities within structures.

Fire was also used for industrial activities at Malyan. Copper-bronze slag, found throughout the site, provides evidence for metallurgy. Metal is widespread in the Kaftari levels. Nickerson (1983) has suggested that small-scale metal refining took place at the household level during Kaftari times. It is noteworthy that charcoal rather than wood is used in smelting, and some woods must be cut green in order to make charcoal (Horne 1982a). Forbes (1964:106) quotes the ancient Greek author, Theophrastus: "The wood of older trees is inferior to that of younger, for the same reason that of really old trees is especially bad. For it is very dry, wherefore it sputters as it burns; whereas wood for charcoal should contain sap."

Horne (1982a) specifically mentions juniper, pistachio, almond, and oak as having the characteristics mentioned by Theophrastus. Although charcoal has a higher caloric value than wood, its manufacture by primitive methods is a very inefficient use of wood fuel (Horne 1982a, b). It cannot be proved that charcoal manufacture increased during the third millennium. However, evidence for smelting is common in both Banesh and Kaftari deposits (W.M. Sumner, p.c.), and even in the absence of a per capita increase in metal use the larger Kaftari population would have required greater quantities of metal. It therefore seems likely that more charcoal would have been produced and burned for smelting.

There is evidence for pottery manufacture at Malyan. The pottery kilns, filled with kiln wasters and probable dung ash post-date the Kaftari occupation of the site, however.

TABLE 8.–*Possible uses of woody taxa at ancient Malyan.*

Taxon	Wood	Leaves/ Branches	Fruits
Juniper	fuel[1] timber[3]	fodder	medicine[3]
Almond	fuel[1,2,3] timber	fodder[2]	fodder[2] food[1,2]
Maple	fuel[1,2,3] timber[3]		
Pistachio	fuel[1,2] timber[3]	fodder[2]	food[2,3] (presume[1])
Oak	fuel[1,2] timber[3]	fodder[2]	fodder[2] food[3]
Poplar (largely cultivated now)	fuel[1,2] timber[1,2,3]		
Ash	fuel timber[3]		
Plane (some cultivated today)	fuel timber[3]		
Vitex	fuel		food[3]
Caper	fuel		fodder[3]
Prosopis	fuel		food[3]
Grape (cultivated only)	fuel[2]	food[3]	food[1,2,3]
Daphne	fuel		
Rhamnaceae	fuel		
Ulmaceae	fuel[1] timber[3]		

[1]Archaeological evidence from in situ oven/hearth/kiln (fuel) and latrine (food) deposits, including post-Kaftari deposits.

[2]Ethnographic observations and discussion with villagers.

[3]Published references for Near East (e.g. Wulff 1966, Townsend and Guest 1966, et. al.).

Alden (1982) has found several Banesh pottery manufacturing sites near the mountains and suggests their location may be due in part to their proximity to fuel. The few pieces of charcoal recovered from one of these sites neither support nor refute this proposition (Miller 1980).

Lime production would also have used up large quantities of fuel, considering the substantial evidence at Malyan for the use of plaster for walls, floors, and containers (Blackman 1982). It is appropriate to point out that Malyan, as the center of an urban system, could well have drawn finished products (notably lime and pottery) from its hinterland; direct evidence of fuel use for these manufacturing activities would therefore not appear at the site, even if deforestation may be inferred on the basis of the charcoal assemblage from the ancient city.

Construction.—Contemporary construction techniques are similar to those found archaeologically; for descriptions and discussion of traditional techniques in use, see Wulff (1966), Watson (1979) and Kramer (1982). Both present-day and ancient structures are made of sun-dried mud brick. The former, and presumably the latter, have wooden roof beams covered with mats, brush, and a layer of hard-packed mud. Today, poplar and willow are the primary woods used for roof beams. A large burnt public building, dating to about 400 years after the Kaftari period, had an abundance of poplar charcoal. The large chunks found in association with other roofing material (grass or reed stem, from matting) suggest that by 1200 B.C. poplar was used for beams. Juniper (*J. excelsa* M.B.) may grow to a height of 20 m; its wood is "light and not particularly strong," but it could provide durable wood suitable for beams (Townsend and Guest 1966). Although none has been found to date in this context, the excavator has suggested that some Kaftari period rooms may be too wide to have been spanned by poplar beams, which have a maximum usable length of about 4 m (W.M. Sumner p.c.).

In any case, despite population increase in the valley, the cutting of trees for roof beams for local use would probably not be sufficient to cause deforestation. If long-distance trade in wood were important for construction material (the suggested reason for depletion of the Lebanese cedar forests, for example) or ships (for example, in the Mediterranean region during Classical times, Hughes 1983), this could be a factor in deforestation. Data are not available to assess this possibility.

Tool manufacture.—Although no wooden tools have been found, there is no reason to doubt that wood was used for utensils, tool handles, containers, ornaments, and other objects. The manufacture of wooden artifacts is not likely to put as great a stress on the forests as fuel use and construction.

Grazing.—The role of grazing in deforestation could be quite significant, especially if animals were brought to forests that were already under stress from fuel-cutting. Goats and camels can be observed today in the oak forest nibbling on oak, pistachio, and almond trees, and undoubtedly they browsed these species during ancient times.

Land clearance.—No forest remnants occur on the plain today, but this has not always been the case (Kortum 1976:84). New fields could have been prepared by removing the trees. If the trees were burned, no archaeological evidence would be left. If the wood was used as fuel, one might expect to find some charred remnants on the site.

The activities of human populations which are destructive to forests may be counteracted by tree planting. Whether or not some individual trees had been cultivated in antiquity cannot be determined, since the wood of cultivated trees cannot be distinguished from the same species growing wild. With the exception of grape, which is thought not to be endemic to southern Iran, the woody taxa found archaeologically all occur in the wild today and many are also cultivated. Although the pistachio and almond of commerce are not now grown in the area, nor are they found archaeologically, nuts of wild pistachio[12] and almond[13] are collected today by villagers and are also found archaeologically. Although contemporary use of acorns is widespread—goats enjoy them, they are used in tanning leader, and nomands used them for flour—acorns have not been found in archaeobotanical samples. Grape is the only woody plant with edible fruits or nuts that one can safely assume was planted at ancient Malyan. Wood of the grape would represent incidental use as fuel.

DEFORESTATION IN THE KUR BASIN

Initially, forest clearance close to Malyan may have been undertaken to provide agricultural land. Population estimates for earlier fourth millennium occupation exceed those of the Banesh period, and presumably some forest clearance in the Kur River basin was already underway. In the absence of climatic and archaeobotanical data, the degree of disturbance cannot be estimated. However, the Kaftari population increase could certainly have led to the clearing of primary or secondary forest.

Horne (1982a) has suggested that the vast amounts of wood required for charcoal used in metallurgy can also lead to rapid depletion of forests. This is certainly a possibility for later antiquity; Wertime (1983) considers that the "pyrotechnical industries" were the primary cause of Mediterranean deforestation. As mentioned earlier, the choice of slow-growing juniper as a fuel would deplete a nearly non-renewable resource, particularly if the trees were cut down rather than pruned. Note further that juniper would have grown on the well-drained part of the plain, on land otherwise suitable for agriculture, whereas poplar would not have interfered with cultivation. A complicating factor is the apparent increase in the use of metal at Malyan and elsewhere in the Near East during the third millennium. Juniper could have been a preferred fuel for this activity. As the Classical author Theophrastus commented (although not specifically in reference to bronze manufacture and juniper): "Smiths require charcoal of fir rather than of oak; it is indeed not so strong, but it blows better into a flame as it is apt to smoulder less; and the flame from these woods is fiercer." (quoted in Forbes, 1964:107)

The archaeological context of the finds, particularly the absence of any evidence of burned structures in the Banesh and Kaftari levels, suggests that most of the charcoal probably represents the remains of spent fuel. The deposits characterized by high densities of charcoal probably represent primary hearth deposits or secondary dumping of hearth debris. The charcoal from low-density deposits has been interpreted as dispersed refuse. Since a major limiting factor for the use of firewood is transport costs; charcoal is lighter than wood, and its manufacture is one way to reduce transport costs. Charcoal production sites by their nature are ephemeral (cf. Horne 1982b) and would be difficult if not impossible to discover archaeologically. Although it is not possible to determine whether wood or charcoal was the preferred fuel, one may still apply least effort considerations to the problem of fuel use. Those collecting areas nearest the site would be used first, especially in a time of non-mechanized transport. One might expect charcoal percentages to reflect species availability within the shortest radius from the site.

During Banesh times, the fairly high proportion of juniper in the archaeological samples suggests that it may have been a major component of the pistachio–almond steppe forest that extended from the lower slopes down onto the plain. If this were the case, the juniper population seems to have been nearly completely removed from the environment between Banesh and Kaftari times. Textual support for depletion of juniper in southern Iran is provided by Hansman (1976), who has suggested that the ancient territory of Elam, east of Sumer, is "the land of the cut-down ERIN-trees" referred to in the Gilgamesh epic. During the third millennium, the Sumerian epic hero Gilgamesh must travel through this territory in order to obtain ERIN wood, which Hanseman suggests is *Juniperus excelsa* on epigraphic and phytogeographical grounds.

Poplar probably grew in the poorly drained marshy area to the east of the site and is unlikely to have been a preferred fuel. Like juniper, the importance of poplar for fuel seems to decrease between Banesh and Kaftari times. It may have grown naturally on marsh land that today is completely treeless and used for pasture. Unlike juniper, which is virtually absent in the area today, poplar did not disappear from the environment because it is intentionally grown and protected by people. The decline of poplar charcoal in the archaeological samples from the Kaftari period may be due to a change in its primary use, from fuel (or construction and fuel) to construction.

During Kaftari times, the major woods used for fuel were those characteristic of the modern oak forest. Today, the plain seems to be at the southeastern limit of oak forest, so it is likely that the oak in the archaeological samples grew at high elevations. Some juniper could have grown on the plain or within the oak forest. There are at least two explanations which can account for the increase in the percentage of oak charcoal at the expense of juniper at Malyan. First, juniper could have been a preferred fuel wood, and a component of the oak forest in Banesh times, especially if charcoal manufacture for smelting was a significant factor. After the depletion of juniper from the forest, it would have been replaced by the more competitive oak. Note, however, that both juniper and oak yield charcoal that is suitable for smelting. Second, juniper could have been primarily a tree of the pistachio-almond forest near the site. This would accord better with the modern distribution of juniper. Whether or not juniper was preferred, it seems to have been removed first. Since oak would not have grown near the site, the increase in oak charcoal suggests that an increase radius of procurement was necessary to provide fuel for the city. The increased use of dung as an alternative fuel also suggests a decrease in local supplies of wood for fuel.

The other major genera found archaeologically (almond, pistachio, and maple) all interdigitate with oak in this part of Iran, depending on local climatic conditions. As these genera are dominant in plant associations of the warmer and drier climes to the south and east, they may have been associated with juniper on the plain during Banesh times, and possibly continuing into Kaftari times. They may have spread at the expense of juniper during the Kaftari period, but, due to fuel cutting and agricultural expansion, were eventually restricted to the more distant mountains, where they are found today.

Finally, there are only minute amounts of wood that may have come from the center of the plain, *Prosopis* and caper. Both of these shrubs provide edible fruit but are quite different in their properties. *Prosopis* provides high-quality fuel (Isely 1982), but it has only been seen growing to a height of less than 20 cm. Caper is extremely thorny and painful to collect; it is difficult to account for the presence of its charcoal for any purpose. One would not expect wood from these shrubs, particularly caper, to have been used regularly as fuel, especially if there were a closer source of wood. In keeping with our knowledge of the settlement pattern, the few pieces of caper and *Prosopis* charcoal (as well as three and a half *Prosopis* seeds) which would have come from at least 30 km away were recovered from the later levels, when settlement on the plain does seem to be more oriented toward the southwest.

CONCLUSIONS

Results of the analysis of charcoal from Malyan suggest that the economic activities of the ancient population caused long-term vegetation changes. The non-marsh vegetation of the Kur River basin, hypothesized as a pistachio-almond-maple-juniper association was either deforested or reduced to a pistachio-almond-maple association. In addition, the radius for fuel procurement seems to have expanded along with the expanding demand of the growing urban population for fuel and land—to include the areas of oak forest in the mountains.

ACKNOWLEDGMENTS

Thanks are due H. T. Wright, R. I. Ford, W. M. Sumner, T. L. Smart, and several anonymous reviewers for their critical comments on earlier versions of this paper. C. C. Townsend of the Royal Botanic Garden at Kew kindly provided identifications for the modern comparative material (except for *Juniperus* cf. *excelsa).* Don Strickland gave helpful advice on the content and presentation of Table 2. Thanks are also due to the

Malyan crew, directed by William Sumner, without whom the data presented in this paper could never have been collected.

This research was supported by a Malyan Graduate Research Assistantship under NSF (SOC75-1483) and a Rackham Pre-doctoral Dissertation grant from the University of Michigan. The Malyan Project field work was sponsored by the University Museum, University of Pennsylvania, with additional major financial support from the National Science Foundation, the National Geographic Society, the Metropolitan Museum of Art, and the Ohio State University.

An earlier version of this paper entitled "Paleoethnobotany at Malyan" was presented at the annual meeting of the Society for American Archaeology, Philadelphia, May 1, 1980.

LITERATURE CITED

ABTAHI, J., A. FARSHADI, and I. FEILI. 1970. Summary of Detailed Reconnaissance Soil Survey Report of Doroodzan Area, Ostan Fars, Iran. Soil Institute of Iran Publ. 207. Tehran.

ALDEN, J. R. 1982. Marketplace exchange and indirect distribution: An Iranian example. Pp. 83-101 *in* The Contextual Analysis of Prehistoric Exchange Systems (J. Ericson and T. Earle, eds.). Academic Press, New York.

AMIET, P. 1979. Archaeological discontinuity and ethnic dualities in Elam. Antiq. 53:195-205.

BLACKMAN, M. J. 1982. The manufacture and use of burned lime plaster at Proto-Elamite Anshan (Iran). Pp. 107-115 *in* Early Pyrotechnology: The Evolution of the First Fire Using Industries (T. Wertime and S. Wertime, eds.). Smithsonian Institution, Washington D.C.

BOBEK, H. 1951. Die natürlichen Wälder und Geholzfluren Irans. Bonner Geographische Abhandlungen 8:7-62.

————. 1952. Beiträge zur klimaökologischen Gliederung Irans. Erdkunde 6(2/3):65-84.

CHISHOLM, M. 1962. Rural Settlement and Land Use. John Wiley, New York.

CONRAD, L. A., and R. C. KOEPPEN. 1972. An analysis of charcoal from the Brewster site (13Ck15), Iowa. Plains Anthrop. 17:52-54.

DAY, G. M. 1953. The Indian as an ecological factor in the northeastern forest. Ecology 34:329-346.

FORBES, R. J. 1964. Studies in Ancient Technology, vol. 8. E. J. Brill, Leiden.

FOREST RESEARCH INSTITUTE AND COLLEGES. 1972. Indian Forest Utilization (2 vol.). Forest Research Institute and Colleges, Dehra Dun, India.

GIBSON, M. 1974. Violation of fallow and engineered disaster in Mesopotamian civilization. Pp. 7-19 *in* Irrigation's Impact on Society (T. E. Downing and M. Gibson, eds.). Univ. Arizona Press, Tucson.

GRAVES, H. S. 1919. The Use of Wood for Fuel. USDA Bulletin 753.

GREAT BRITAIN. 1945. Persia. Naval Intelligence Division, Geographical Handbook Series B. R., no. 525.

GREGUSS, P. 1959. Holzanatomie der Europaischen Laubholzer und Straucher. Akademiai Kiado, Budapest.

HAJAZI, R. 1965. Asul-e Tashrih-e Chub (Principles of Wood Anatomy). Tehran Univ. Publ. 237, Tehran.

HANSMAN, J. 1972. Elamites, Achaemenians, and Anshan. Iran 10:101-125.

————. 1976. Gilgamesh, Humbaba and the land of the ERIN-trees. Iraq 38:23-35.

HEIZER, R. F. 1963. Domestic fuels in primitive society. J. Roy. Anthrop. Inst. of Eng. and Irel. 93:186-194.

HELBAEK, H. 1960. Ecological effects of irrigation in ancient Mesopotamia. Iraq 22:186-196.

HORNE, L. 1982a. Fuel for the metal worker. Expedition 25(1):6-13.

LITERATURE CITED (continued)

———. 1982b. The demand for fuel: Ecological implications of socio-economic change. Pp. 201-215 *in* Desertification and Development, Dryland Ecology in Social Perspective (B. Spooner and H. S. Mann, eds.). Academic Press, London.

HUBBARD, R.N.L.B. 1980. Development of agriculture in Europe and the Near East: Evidence from quantitative studies. Econ. Botany 54: 51-67.

HUGHES, J. D. 1983. How the Ancients viewed deforestation. Jrnl. Field Arch. 10:437-445.

ISELY, D. 1982. Leguminosae and *Homo sapiens*. Econ. Bot. 36:46-70.

JACOBSEN, T., and R. M. ADAMS. 1958. Salt and silt in ancient Mesopotamian agriculture. Science 128: 1251-1258.

KORTUM, G. 1976. Die Marvdasht-Ebene in Fars. Kieler Geographische Schriften 44.

KRAMER, C. 1982. Village Ethnoarchaeology. Academic Press, New York.

LLOYD, S. 1978. The Archaeology of Mesopotamia. Thames and Hudson, London.

MALLOWAN, M.E.L. 1971. The Early Dynastic period in Mesopotamia. Pp. 238-314 *in* Cambridge Ancient History, vol. 1, pt. 2. Cambridge Univ. Press, Cambridge.

METZGER, D. G., and G. WILLIAMS. 1966. Some procedures and results in the study of native categories: Tzeltal "firewood". Amer. Anthrop. 68:389-407.

MIKESELL, M. W. 1961. Northern Morocco, a Cultural Geography. Univ. California Press, Berkeley.

MILLER, N. F. 1980. Ethnobotanical report—Tal-e Kureh. Unpubl. ms. on file, Univ. Mich. Mus. Anthro. Ethnobot. Lab. Report 560. Ann Arbor.

———. 1982. Economy and Environment of Malyan, a Third Millennium B.C. Urban Center in Southern Iran. Univ. Microfilms, Ann Arbor.

MILLER, N. F., and T. L. SMART. 1984. Intentional burning of dung as fuel: A mechanism for the incorporation of charred seeds into the archeaological record. J. Ethnbiol: 4:15-28.

MINNIS, P. E. 1978. Paleoethnobotanical indicators of prehistoric environmental disturbance: A case study. Pp. 347-366 *in* The Nature and Status of Ethnobotany (R. I. Ford, ed.). Univ. Mich. Mus. Anthro., Anthrop. Papers 60.

MOOREY, P.R.S. 1982. The archaeological evidence for metallurgy and related technologies in Mesopotamia c. 5500-2100 B.C. Iraq 44:13-38.

NICHOLAS, I. M. 1980. A Spatial/Functional Analysis of Late Fourth Millennium Occupation at the TUV Mound, Tal-e Malyan, Iran. Univ. Microfilms, Ann Arbor.

NICKERSON, J. A. 1983. Intrasite Variability during the Kaftari Period at Tal-e Malyan (Anshan), Iran. Univ. Microfilms, Ann Arbor.

PABOT, H. 1960. The native vegetation and its ecology in the Khuzistan river basins. (Mimeo).

RALPH, E. K., H. N. MICHAEL, and M. HAN. 1973. Radiocarbon dates and reality. MASCA Newsl. 9(1):1-20.

REINER, E. 1974. Tall-i Malyan, epigraphic finds, 1971-72. Iran 12:176.

RIEDL, H. 1968. Cupressaceae. Flora Iranica, vol. 50 (K.H. Rechinger, ed.). Akademische Druck, Graz, Austria.

SABETI, H. 1966. Native and Exotic Trees and Shrubs of Iran. Publ. 1037, Tehran Univ., Tehran. (In Persian, with distribution maps in Latin).

STOLPER, M. W. 1976. Preliminary report on texts from Tal-e Malyan, 1971-1974. Pp. 89-100 *in* Proc. of the IVth Ann. Symp. on Arch. Research in Iran, 1975 (F. Bagherzadeh, ed.). Iranian Centre for Archaeological Research, Tehran.

SUMNER, W. M. 1972. Cultural Development in the Kur River Basin, Iran. Univ. Microfilms, Ann Arbor.

LITERATURE CITED (continued)

__________. 1974. Excavations at Tall-i Malyan, 1971-1972. Iran 12: 155-180.

SUMNER, W. M. (ed.). 1980. Problems of large scale, multi-disciplinary regional archaeological research: The Malyan Project. Soc. Amer. Arch. Ann. Meeting, Philadelphia. (Mimeo).

THALEN, D. P. 1979. Ecology and Utilization of Desert Shrub Rangelands in Iraq. Dr. W. Junk B.V., The Hague.

TOWNSEND, C.C., and E. GUEST (eds.). 1966. Flora of Iraq, vol. 2. Ministry of Agriculture, Baghdad.

VAN ZEIST, W., and S. BOTTEMA. 1977. Palynological investigations in western Iran. Palaeohist. 19:19-85.

__________. 1982. Vegetational history of the eastern Mediterranean and the Near East during the last 20,000 years. Pp. 277-321 *in* Palaeoclimate, Palaeoenvironments and Human Communities in the Eastern Mediterranean Region in Later Prehistory (J. L. Bintliff and W. van Zeist, eds.). B.A.R. Int'l. Series 133.

WATSON, P. J. 1979. Archaeological Ethnography in Western Iran. Viking Fund Publication 57. Univ. Arizona Press, Tucson.

WERTIME, T. A. 1983. The furnace versus the goat: The pyrotechnologic industries and Mediterranean deforestation in Antiquity. J. Field Arch. 10:445-452.

WESTERN, A. C. 1971. The ecological interpretation of ancient charcoals from Jericho. Levant 3:31-40.

WILLCOX, G. H. 1974. A history of deforestation as indicated by charcoal analysis of four sites in eastern Anatolia. Anatol. Stud. 24:117-133.

WRIGHT, H. E. 1977. Environmental change and the origin of agriculture in the old and new worlds. Pp. 281-318 *in* Origins of Agriculture (C.A. Reed, ed.). Mouton, The Hague.

__________. 1985. Personal communication.

WULFF, H. E. 1966. The Traditional Crafts of Persia. MIT Press, Cambridge.

ZOHARY, M. 1963. Geobotanical Outline Map of Iran (1:4,000,000). Insert *in* On the Geobotanical Structure of Iran. Bull. Res. Counc. Israel 11D (suppl.).

NOTES

[1]The chronology is based on MASCA corrected (Ralph et. al. 1973) radiocarbon dates from Malyan.

[2]The population estimates may be revised upward as the analysis of the settlement data continues (W. M. Sumner, p.c.).

[3]Poplar (*Populus* sp.), indistinguishable from willow (*Salix* sp.) at these magnifications, was examined under higher magnification.

[4]Collection in possession of author; duplicate material at the University of Michigan Ethnobotanical Laboratory, Ann Arbor. It is unfortunate that few wood atlases are available which include the major trees of Iran. Greguss (1959) has some of the useful fruit and timber trees, and Hajazi (1965) has poorly reproduced photographs of woods from trees of the northern Zagros and Caspian forests. For those who are interested in the documentation of the modern wood specimens, descriptions and SEM photographs (transverse, 50x; tangential, 100x; radial, 100x and 300x) are available (Miller 1982).

[5]Hand-picked samples come from 35 Banesh and 40 Kaftari deposits. Banesh: 5 hearths, 1 pits, 21 rooms, 8 matrix. Kaftari: 10 pits, 16 rooms, 14 matrix.

NOTES (continued)

[6]Flotation samples come from 99 Banesh and 89 Kaftari deposits. Banesh: 18 hearths, 16 pits, 49 rooms, 3 burials, 6 jars, 7 matrix. Kaftari: 4 hearths, 28 pits, 32 rooms, 3 jars, 22 matrix.

[7]The completed analysis of the materials appears in Miller (1982) and includes a consideration of charcoal weight, density per volume of soil, and differential distribution of charcoal within the site. The complete data set is presented sample by sample for those who wish to use it.

[8]The excavation areas were chosen to answer certain archaeological questions about stratigraphy, the extent of settlement, and the range of variability on the site (Sumner 1980).

[9]*Quercus aegilops* L. ssp. *persica* (J. & S.) Blakelock.

[10]*Juniperus polycarpos* C. Koch = *J. excelsa* M. B. (Riedl 1968).

[11]Cf. Day (1953): "So important was firewood in Indian economy that the Naragansetts of Rhode Island thought the English had come to America because they lacked firewood at home," and they even lived in the tempe*ratre forest zone!

[12]*Pistacia* cf. *eurycarpa* Yalt.

[13]*Prunus* cf. *scoparia* (Spach) C. K. Schneider = *Amygdalus scoparia* Spach; *Prunus* cf. *kotschyi* (Boiss. & Hohen.) Nab. = *A. kotschyi* Boiss. & Hohen.

Book Review

Plants and Ancient Man, Studies in Palaeoethnobotany. Edited by W. Van Zeist and W.A. Casparie. 344 pp., illus. A.A.Balkema Publishers, Boston, 1984.

The International Work Group for Palaeoethnobotany first convened in Prague, Czechoslovakia in 1968 and it has held meetings every three years hence. **Plants and Ancient Man** contains the proceedings of the sixth symposium sponsored by the State University of Groningen in The Netherlands in 1983. The thirty papers presented in this volume cover methodological problems, the use of documentary evidence, ethnographic models, and various European regional studies. A special section is devoted to the identification of archaeological wheats.

The papers by Hillman and Jones discuss the potenials and problems of applying ethnographic models for cereal processing derived from Turkey and Greece, for interpreting prehistoric plant remains. Hillman's contribution also contains a test of his model on a palaeoethnobotanical assemblage from *Cefn Graeanog* in Wales. Willerding (Central Europe), Behre (Germany), and Green (England) explore the botanical content of medieval maps, tax lists, paintings, court documents, herbals, brewery recipes, cook books, monastic texts, and market records. Green and Behre also compare the documentary evidence with the archaeological record. Forni analyzes the linguistic roots of Indo-european agricultural terms to derive a unitary hypothesis for plant and animals domestication that emphasizes the use of fire by prehistoric peoples for environmental manipulation. Kislev (ancient Near East), Jacomet and Schlichtherle (Swiss Lake Dwellings), Janushevich (USSR), and Kosina (modern and prehistoric cultivars) tackle the difficult taxonomic problems of classifying cultivated wheats. The study by Van Der Veen (Iron Age England) compares the results of random and judgement sampling in flotation analyses. The two approaches produce essentially identical patterns but the absolute density of remains recovered from non-random samples is greater. Using experimental carbonization, Wilson tests the differential destruction and distortion of moist and dry samples of 12 common types of European weed seeds. Greig compares the herbaceous "floras" of modern and Iron Age British hay meadows. Van Vilsteren (Medieval Netherlands) examines the interpretation of charred seeds from postholes. Bottema explores the use of animal dung for fuel as a potential source of charred seeds in archaeological sites. Regional studies are presented by Korber-Grohne (Central European fruit trees), Kroll (Bronze and Iron Age Macedonia), Kucan (Iron Age Yugoslavia), Wasylikowa (Neolithic through Medieval Poland), Pashkevich (Scythian and Greek Crimea, USSR), Lisitsina (Neolithic Caucasus, USSR), Lundstrom-Baudais (Neolithic France), Kuster (Neolithic Germany), Pals (Neolithic Netherlands), Straker (Roman London), Knorzer (Roman through 18th century latrines in Germany), and Paap (Medieval Netherlands).

The papers by Hillman, Jones, and Kosina present pioneering applications of multivariate statistical techniques to palaeoethnobotanical data. Few mathematicians would argue with the use of cluster, discriminant function, or canonical correlation analysis on continuous metric data from wheat caryopses. Some statistical purists, on the other hand may balk at the use of ratio or percentage data in the attempts to classify crop processing residues. I feel that these multivariate techniques can be useful tools for pattern recognition and date reduction if used cautiously.

Plants and Ancient Man has a somewhat limited geographical focus. Only the papers by Harris (North America and Australia), Clarke et al. (Australia), and Shay (Manitoba) touch on regions outside of Europe or western Asia. Nevertheless the volume presents data, methods, and ideas useful for any practitioner of palaeoethnobotany. I only hope that the next Symposium scheduled for the summer of 1986 will attract participants from North and South America, Africa, Oceania, India, Southeast Asia, and China so that it will be more truly international in scope.

CHM

EDIBLE ANIMALS OF THE ITURI FOREST, AFRICA IN THE ETHNOZOOLOGY OF THE EFE BAMBUTI

MARIA ARIOTI
Instituto di Studi Sociali
Facolta de Scienze Politiche
Universita di Perugia
06100 Perugia, Italy

ABSTRACT.–This article presents ethnographic data about the ethnozoology of the Efe Pygmies, hunters and gatherers of the Ituri forest (Northeastern Zaire). It deals particularly with categories of edible animals. The Efe system is compared with that of their Negro neighbors, the horticultural Balese.

INTRODUCTION

This article presents data concerning the ethnozoology of the Efe Pygmies of the Ituri forest (northeastern Zaire, Africa), collected during two periods of fieldwork: July-August 1981 and November 1982-January 1983.[1] I worked among some groups of bow-hunting Efe Bambuti in the zone of Andifere, between Mambasa and Nduye. The Efe are traditionally linked to the horticulturalist Balese through a complex relationship of interdependence. This symbiotic relationship results not only in economic transactions, but also in intermarriage, common ceremonies and, above all, shared knowledge, beliefs, and values (Schebesta, 1938-1950). Anthropologists who study Pygmies are faced with the problem of discerning the contribution of each ethnic group to this common cultural inheritance. It is a difficult, in some ways impossible, operation.

In the specific case of ethnozoological classification, however, there is little doubt it is an original product of Pygmy thought. I extended my research work to the Balese and discovered they have a classification almost exactly akin to that of the Pygmies, with only a few significant differences. The Balese themselves are aware that they have assimilated Pygmy Knowledge about the forest. They maintain that the Efe introduced them and guided them in the unknown, hostile forest and taught them names and uses of animals and plants. In this article I will point out similarities and differences between the Efe and the Balese classification systems.

The Efe and the Balese speak two very close dialects of the same language (Vorbichler, 1974). The Pygmies call their own language Efe or, less often, Kimbute, and use the term Kilese for the language of the Balese. Moreover, both groups are completely bilingual in Kingwana (a Swahili dialect introduced into this area by the arabized tribe of Bangwana) and they generally use Kingwana in a wide range of contexts. It seemed to me, however, that the attitude of female Efe toward Kingwana is different from that of male Efe. Women speak and understand Kingwana, but they are less willing than men to use it, particularly in their camps.

In the study area several other ethnic and linguistic groups live together. The most important are the horticulturalist Babira and the net-hunting Basua Pygmies. The Babira and the Basua are linked by a close bond, in the same way as the Balese and the Efe, and both speak Kibira. In a Pygmy camp of Efe it is possible to meet some people who speak Kibira, mixed with the majority of Kilese speakers. These people had generally moved into the Efe band after marriage. On the whole, the permeability between linguistic groups is strong and sometimes it is difficult to ascertain if a term is Efe, Kibira or Kilese. I will note in this article the terms which are used interchangeably by Kibira and Efe speakers.

METHODS

I carried out my research using Kingwana, with the assistance of a bilingual interpreter (Kingwana-Kilese). Kingwana has undergone adaptation to local situations. In regard to the Pygmies, this process resulted in an almost complete correspondence between Kingwana and Kilese terminology.

Only one of the Pygmies I met had gone to school. He was about 35 years old, had attended a primary school for two years, but could read only with the greatest difficulty and was unable to write. On the contrary, in each Balese village there were two or three people, usually men, who were able to read and write quite well, and were able to speak a little French. I found that the level of education of informants is a very important point in ethnoscientific research. The anthropologist must be aware that it can affect the quality of his or her work. Indeed, I noticed, for example, that Balese education people immediately grasped the idea of the taxonomic tree and afterwards tried to force all given information into this structure. Fortunately, they contradicted themselves and each other frequently enough to make me understand that they were just playing with an appealing new idea. As a matter of fact, non-educated Balese and Efe people either did not grasp or simply refused the taxonomic tree model.

The Pygmies do not like to work as informants individually and regularly. Only two people—one of whom was the educated man mentioned above—agreed to work with me in this way. In each camp, people preferred to gather and talk with me as a group, consulting each other before they answered. I discovered that this was a very fruitful method. From the questions they put to each other, and from the answers to these questions, and from the doubts they expressed, I got more information than in my work with regular informants.

In contrast, I worked often with single Balese individuals. They prefer to be alone, I suspect, because they are very proud and do not like to be found to be at fault by other people. Among the Balese, only children were ready to start collective conversations.

In a few cases I tried to talk with the Balese and the Efe together. I noticed that when the conversation took place in a Balese village, the Balese assumed an attitude of superiority toward the Efe, preventing them from speaking. However, in a Pygmy camp in the forest they agreed to talk on the same level.

In the first stage of my research work, I put forward tentative questions, at the same time showing them the pictures of some animals, just to start a conversation about the matter I was interested in. Both the Efe and the Balese were enthusiastic about pictures and would always begin talking to each other or to me endlessly, trying to identify each animal exactly, and thus giving me much information about names of single beasts, main categories, and identification criteria.

A final methodological remark is necessary. I present my data in a descriptive way, without systematizing it into any model. In fact, I think that at present there are not enough comparative data to allow generalizations about universal principles of ethnozoological classification. Indeed, my data do not fit any of the models proposed up to now (Berlin, Breedlove, Raven, 1973; Hunn, 1982). So, this paper is intended to be a strictly ethnographic contribution to add to the knowledge of a so far neglected aspect of Pygmy culture.

I do not use the terminology prevalent in ethnotaxonomy proposed by Berlin, Breedlove and Raven (1973). Instead, the similarity between my data and that collected by Morris (1976) among the Hill Pandaram, a hunting and gathering people of Southern India, convinced me to adopt his terminology. I use the term "taxa primaria" or "classes" or "categories" to indicate all the groups of organisms which are not included in other taxa, "intermediate taxa" to indicate all the taxa included in taxa primaria and including other taxa, and "taxa terminalia" all the taxa included either in taxa primaria or in taxa intermedia and not including any other taxa. The terms "genus", "generic" and "species", "specific" are used only in the biological sense.

ANIMAL REALMS: EDIBLE VERSUS INEDIBLE ANIMALS

There is no term for 'animal' either in Kilese, Efe or Kingwana. As far as I could ascertain, the Efe do not recognize via terminology or in any other way the existence of one unitary realm, including all those living beings which we consider to be animals. They lack what Berlin, Breedlove and Raven (1973) call 'unique beginner'.

The most comprehensive term they have is ***uura***, which is exactly translated in Kingwana as nyama (best, meat).[2] This term, as we will see below, has many different meanings, the most important and explicit being all edible animals. There is no corresponding term in Efe for all inedible animals, which, therefore, constitute a sort of residual category.[3] Sometimes the Efe use the Ngwana word ***vilulu*** to designate them, which is usually translated as insects, but which includes also worms, spiders, and more generally all little animals. The Balese have the same term ***uura***, but they also have a term, ***baasi***, which covers all inedible animals, with only a few exceptions which I will consider below.

It is important to point out that this distinction between edible and inedible animals is a very precise one and none of the categories into which the Efe put animals include both. So, we can say that in one sense edible and inedible animals constitute two separate realms.

DIFFERENT MEANINGS OF *UURA*

The Efe use the term ***uura*** with at least three different meanings. The first, as stated above, is all edible animals, and is the widest and also the most formal and explicit. Not only are hunted game thus considered to be ***uura***, but also fish, crabs, and small animals such as turtles and snails. When I asked people to tell me if a certain animal was or was not ***uura***, they always answered me: "It is ***uura:*** we eat it", or "It is not ***uura:*** we do not eat it."

In a more limited sense, the term is used to designate mammals. This use is not explicit; I have inferred this from the answers of people. When I asked them to tell me all the ***uura*** names they knew, they always started to list the main hunted animals—antelopes and wild boars—and then added monkeys, leopards, mongooses, genets, and so on. No one gave me spontaneously, in his list, any names of fish, snakes, snails, etc., except for one person, who included the name of a snake. However, when I tried to test their awareness of the semantic field I had inferred, they refused to accept it and insisted that ***uura*** were all edible animals.

Finally, the main hunted animals I have just mentioned represent, more or less a category of ***uura*** *par excellence*. This meaning also is implicit and I have inferred it. As stated above, all lists of ***uura*** I elicited begin with the names of the most common antelopes and wild boars. I noticed also that they always hesitated before adding to these names those of other animals, for example, monkeys.

To the term ***uura*** can be added some modifying words. So we have, for example, the expressions ***uura meli*** and ***uura ubopo***, which indicate, respectively, the ***uura*** living in the forest and the ***uura*** living in the villages, such as goats (***meme;*** in Kingwana ***mbuzi)*** and chickens (***ibabu***; in Kingwana ***kuku)***. Another expression, ***uura ogbu***, is used, more commonly by the Balese, to designate all big game.

The Balese use the term ***uura*** with the same basic meanings. However, it covers a narrower total field, because the Balese do not eat all of the animals that the Efe do. In formal contexts of elicitation, some educated Balese people were inclined to limit the use of the term ***uura*** to the two more restricted meanings. However, in informal conversation they contradicted themselves often. The dietary restrictions placed upon boys during the ceremonies of initiation and upon pregnant and post-partum women show that the widest meaning of ***uura***—all edible animals—is correct and in common usage also among the Balese. As a matter of fact, the forbidden animals are called ***uura inda*** (an expression which was translated in Kingwana as ***nyama mbaya:*** bad beast, meat), and include also fish, birds, etc.

UURA CATEGORIES

The Efe subdivide ***uura*** into six larger taxa primaria, five of which have their own name, while one is unlabeled. The five named categories are: ***osa*** (birds), ***uua*** (snakes), ***ufu*** (fish), ***odi*** (monkeys), and ***aja-aa*** (a mixed category which includes felines, rodents, etc.). The last unnamed category corresponds to the third meaning of the term ***uura***, I stated above. In this paper I will refer to it as ***uura** par excellence*.

To these must be added five smaller categories: ***bea*** (turtles), ***arigba*** (snails), ***ecbu*** (termites), ***aruja*** (a kind of worm), and ***ei-ei*** (the larvae of some kinds of Coleoptera). Finally, there are small number of animals which are considered ***uura***, but are not affiliated in any of these categories, or ambiguously affiliated.

The Balese have exactly the same categories. However, it must be pointed out that one of these cannot be considered ***uura***. As a matter of fact, the Balese consider snakes disgusting and do not eat them. This introduces an element of disorder into the Balese system of classification, to which I will return later.

In addition to these well defined categories, I elicited a term which labels a group of animals with no precise boundaries and which crosses other categories. It is ***uura uiebolu***, which indicates all aquatic animals except those included in the ***ufu*** category. All the categories mentioned above are discussed in more detail below.

Uura** par excellence*—This category includes antelopes and wild boars. Wild boars are considered to be brothers of antelopes and are in no way separated from them. All Pygmies, enumerating animals falling into this category, grouped them according to size, so that wild boars were put together with large-sized antelopes. Both the Efe and the Balese say that these animals are akin because they have the same hooves ***(ija).

It is noteworthy that no Pygmy ever mentions in this class elephant (***uu***) and rarely buffalo (***tupi***), although both are hunted in the area and their meat is highly appreciated. When I asked if they considered these animals "brothers" of antelopes, people seemed a little puzzled. Some of them told me that buffalo was almost the same size as the biggest antelopes, especially ***oapi*** (*okapi*), so it could be considered akin, but not really "brother" because of its wildness. The elephant, on the other hand, was considered to be on its own, because of its enormous size.

On the contrary, the Balese state that both elephant and buffalo are very similar to other animals in this category, into which they also put oxen, which are not present in this area and only recently were introduced by missionaries in its northern part.

The category is subdivided into a small number of taxa terminalia (I elicited 10 terms for antelopes, 2 for wild boars), all labeled by unanalyzable primary lexemes (Berlin, Breedlove, Raven 1973). They are all specific taxa directly included in the category. For example, in this area a few species of the genus *Cephalophus* (duikers) live. Each species has its own name.

It must be pointed out that some of these terms are used both by Kilese and Kibira speaking Pygmies, for example, ***soli*** *(Boocercus euryceros)*. Also Harako (1976:49) records this name among Kibira speaking Basua. He reports also the term ***buluku*** for the little *Cephalophus monticola* as a Kibira term. The Efe call this antelope both ***medi*** and ***buluku*** or ***mboroku***, but they told me that the last word was Kingwana. This information agrees with that of Schebesta (1941:98), who also records both names, ***medi*** and ***mboloko***. The little antelope ***befe*** *(Hyemoschus aquaticus)* is also grouped with aquatic animals (***uura uiebolu***).

Aja-aa—This category includes animals of many different biological families, belonging for the most part to the order Carnivora (Mellivorinae, Viverrinae, Herpestinae, Pantherinae, Fossinae, etc.), but also Rodentia and Insecivora. The Efe say that all these animals are similar because they have the same footprint, which in turn is very different from the footprings of all other ***uura***.

Aja-aa are subdivided into a small number of taxa terminalia. Informants agreed upon only 14 taxa. They are all labeled by unanalyzable primary lexemes. Some of these taxa are definitely specific, as, for example, ***au***, leopard *(Panthera pardus)*, ***chamu***, african civet *(Viverra civetta)*, ***abee***, gaint elephant shrew *(Rynchocyon cirnei)*. Some others are generic, as ***egbu*** (genets). All are directly included in the category, which is the same for the Balese, who called it ***aja-baba***.

Two terms I elicited are almost the same also in Kibira: ***dere***, mongoose, and ***borogboro*** *(Crossarchus obscurus)* are called in Kibira ***ndele*** *and kpolokpolo. However, Harako* (1976:49) identified the first animal as *Atilax palidinosus* (marsh mongoose), while the Efe told me it was ***dere*** *Bodeogale nigripes* (black-footed mongoose), and the Efe name for *Atilax palidinosus* was ***fidifidi***. They added that ***fidifidi*** spends much time in water, so one can also call it ***uura uiebolu*** (in Kingwana, ***lombe***).

Odi–Both the Efe and the Balese call all moneys and apes ***odi*** (however, the Balese pronounce it with aspiration, ***hodi***). They say that ***odi*** differ greatly from other ***uura*** because of their general appearance, their ***sura***, which is similar to that of man.

This category is subdivided into a small number of taxa. I elicited twenty terms, which for the most part label biological specific and terminal taxa. They are all unanalyzable primary lexemes. For example, the term ***dato*** indicates chimpanzee, and different names are attributed to the different biological species of *Colobus* present in the area.

There are two ambiguous cases that I was unable to resolve. Regarding the first, I noticed that two names in some ***odi*** lists were distinct, ***mbela*** and ***muo***, in some others they were combined, ***mbela muo***. I tried to discover whether or not they were different names of different species, but my efforts resulted in nothing. Somebody told me that ***mbela*** and ***muo*** were two different names for to different monkeys, and that ***mbela muo*** was not a correct form; somebody else said that they were three equivalent names for one and the same animals; a third informant maintained that the three terms were all correct names of three different animals. In the second case, several people gave me two different terms, ***bisi*** and ***agbisibisi***, for two species of galagos. Afterwards, other people gave me the same terms, but reversed. When In investigated this matter further, their answers were as contradictory as in the first case.

Uua–All snakes fall into this category. The main characteristic is the absence of legs. *Uua* are subdivided into some terminal taxa (people agreed upon only 13 taxa), labelled by primary lexemes, including both analyzable and unanalyzable forms. Some members in this category have no names and are designated simply as ***uua***. They are the smallest snakes. As a matter of fact, informants usually arranged snakes according to their size, noting if they were poisonous or not poisonous. Then, they said that other snakes were too small to have a name. It must be remembered that the Balese do not consider ***uua*** to be ***uura***, because they do not eat them. They say that the big intestinal worms fall into this category also.

Ufu–The category ***ufu*** includes all fish, mollusks and crustaceans. However, some people told me that crabs, for example, are more akin to spiders or to turtles, because of similarities in their appearance, legs and shells. I did not go deeper into this point. I elicited the terms for 14 terminal taxa, upon which all informants agreed; they are all primary lexemes.

The Balese subdivide ***ufu*** into two subcategories: ***ufu sei***, small fish, no longer than 30 cm, and ***ufu ebi***, big fish. The Efe do not make this distinction, and call ***sei*** only a specific small fish, and ***ebi*** a specific big fish.

Osa–All birds and bats fall within this category, which is the widest. I have elicited lists of names which reached fifty, which is more than three times the members of other categories. These terms label taxa which are, for the most part, monolexemic and terminal taxa. However, some of them designate intermediate taxa, under which some, usually two, terminal taxa are grouped. In all these cases, the term which designates the intermediate taxon is polysemic with one of the terms used for the terminal taxon. For example, there are two kinds of ***ebi*** bird (a sort of pigeon), ***ebi*** and ***ebi ene***. (They use the Ngwana word *jiwa* to designate both).

Besides these intermediate categories there are informal groupings of birds. Indeed, informants usually listed birds grouping them according to the kind of next, the nocturnal or diurnal habits, the diet, and kind of voice. Obviously, these groups cross and overlap. Moreover, it must be pointed out that, when I asked them if *ebi*, for example, was more akin to *ebi ene* than to other birds, they always told me that all birds were brothers, and gave me a list of other birds akin to ***ebi*** as for size or voice and so on.

As for bats, I pointed out to both the Efe and the Balese that bats have neither feathers nor beak and that they do not lay eggs, but give birth to their little ones. However, they all insisted on bats being *osa* because they have 'wings'.

The Balese have an identical category. The only difference consists in the name. ***Osa*** is translated to Kilese as ***bali***.[4]

Uura ueibolu—As stated above, all aquatic animals, except those in the ***ufu*** category, fall into this class, which crosses and overlaps many other categories. Also considered to be ***uura uiebolu***, for example, are a species of aquatic antelope, marsh mongoose, crocodile, aquatic turtles, and hippopotamus. This last animal, called ***apfo*** both in Efe and Kilese and ***kiboko*** in Kingwana, is not present in the area, but its name was given me in all lists of ***uura uiebolu***. Some Pygmies had never seen it and described it as a big beast with horn and claws.

Arigba—The ***Arigba*** (in Kingwana ***kora***) category includes snails. Two members, *arigba* and ***magbou***, live in the forest, two others, ***budubudu*** and ***imabududu***, live near the Balese villages. All the terms may be binomialized. So, one can say, for example, ***arigba magbou*** and this form is in common use. Another snail, ***bicbo***, which is not eaten, is considered by the Balese (but not by the Efe) to fall within this category. No Efe ever mentioned it.

Bea—***Bea*** is the name given to the terminal taxon which includes all terrestrial turtles. It is translated in Kingwana as ***kuro***. The Balese call them ***afelu***. They are considered to be akin to aquatic turtles, which are called ***bago*** by the Efe and ***begbeda*** by the Balese. These last animals are considered also to be ***uura uiebolu***.

Ecbu—***Ecbu*** category encompasses all termites, which are subdivided into eight terminal taxa: ***adeiraba***, ***bodi***, ***eabo***, ***esio***, ***ndufu***, ***sara***, ***ndoju***, ***eli***. The Balese call them ***ungu***, a term also used by the Efe, and they use the same names for the eight taxa. They do not consider termites to be ***uura*** (however, they eat them), but call them ***baasi***. The Kingwana term is ***isbwa***.

Ei-ei—All edible larvae are called ***ei-ei***, both by the Balese and the Efe. However, the Balese consider them to be ***baasi***. The most commonly eaten are ***posi*** and ***mobu***, respectively, the larvae of the Coleoptera called ***posi ogu*** and ***opu ogu***.

Aruja—This is the Efe and Balese name of small hairy worms, which irritate the skin, and which are eaten both by the Efe and the Balese. However, the Balese do not consider them ***uura***, but ***baasi***. I elicited only the terms for two terminal taxa: ***aruja*** and ***etepebebe***. The last one can be binomialized (***aruja etepebebe***), but normally is not.

Non-affiliated or ambiguously affiliated ***uura***—The categories I have dealt with so far cover a large part of the ***uura*** realm, but do not exhaust it. There is a small number of edible animals which, for some peculiar charactertistics they present, are not affiliated in any of the mentioned categories, or are ambiguously affiliated. They are: ***aropi*** (flying squirrel), ***ate*** and ***ou*** (two species of pangolins), and ***igbo*** (aardvark). The Balese have the same names for the first three animals, but call the last one ***arufey***.

The majority of people classified ***aropi*** *(Anomalurus)* as ***osa***, because it has wings, pointing out that it was more like a bat (***derebi***). One Pygmy told me that ***derebi*** was a small ***aropi***. However, some other people told me that it can not be considered ***osa***, because it has a tail and fur, and has neither feathers nor beak; instead it was ***odi***. Somebody else mentioned that it was neither ***osa*** nor ***odi***, and that it was simply ***aropi***.

Ou and ***ate***, respectively *Manis tetradactyla* and *Manis gigantea*, are definitely not affiliated. The Efe say that they are ***peke yake***, which in Kingwana means "on their own." The same is valid for ***igbo*** or ***arufey*** *(Orycteropus afer)*; however, this last animal was mentioned in two lists after antelopes and wild boars. Elephant and buffalo, as stated above, can also be considered in one sense not affiliated or ambiguously affiliated in the category of ***uura*** *par excellence*.

CONCLUDING REMARKS

In concluding this ethnographic report, I want to draw attention to some specific points, particularly with regard to differences between Efe and Balese systems of animal classification.

In the first place, there is the primary importance of being edible or inedible, as a principle for classifying animals. Edibility is the quality which permits the distinguishing of two classes of animals, each of which is so large as to be considered similar to what we call a 'realm.' This preeminently cultural criterion operates in a coherent way in Efe classification. It is noteworthy that there are no ***uura*** categories which include both edible and inedible animals. On the contrary, animals of the same genus can be separated only because they are or are not eaten. All inedible animals are for the Efe a sort of residual category, which they do not name; they subdivide them into small categories, which include no other taxa or a small number of terminal taxa.

The same principle works in Balese classification, but in a less coherent way. The Balese also call ***uura*** all edible animals. However, they have a term, ***baasi***, which they say designates all inedible beasts. So, the ***baasi*** category should cover the field not covered by ***uura***. However, this is not the case. On the one hand, the Balese do not eat snakes (***uua***), but they do not consider them to be ***baasi***. On the other hand, they eat termites, larvae and worms, but they call them ***baasi***. Moreover, they tend to introduce into some ***uura*** categories, as the ***arigba*** category, species which are not eaten, thereby creating mixed categories, which sometimes they refer to as ***uura***, sometimes as ***baasi***.

Within the ***uura*** class the Efe group animals into a set of main categories, according to either purely natural or curlturally relevant natural features. Three of these categories, ***osa*** (birds), ***uua*** (snakes), and ***ufu*** (fish), are constructed according to natural absolute characteristics (Hunn, 1982). In the same set we find another group of three categories, ***aja-aa***, ***odi***, and ***uura*** *par excellence*, which are discriminated on the basis of natural features which are relevant only from a cultural point of view. As hunters, the Pygmies give considerable attention to the footprints of the commonly pursued animals, and separate ***aja-aa*** from other terrestrial game on the basis of hooves. In this sense, ***odi*** constitute a sort of residual category, because of the arboreal habits of monkeys.

The Balese have exactly the same categories. However, as I have pointed out, they do not consider snakes to be ***uura***, because they do not eat them, but neither are they ***baasi***. So, in the Balese classification there is one class which remains out of the system. Moreover, the Balese follow the same Efe distinction, which separate ***aja-aa*** from other ***uura***, although it is not very significant for a population which practices only a little hunting, and does not pursue animals, but catches them with traps.

These inconsistencies in the Balese system of animal classification are difficult to explain, unless we admit that the Balese absorbed the Efe system, without solving the contradictions deriving from a different cultural idea of what is edible and what is not, and, more generally, from a different economic relationship with the environment.

It is interesting to note that one of the most educated Balese people, a young man who had gone through primary school, when faced with these contradictions, tried to elaborate for my benefit a more coherent classification. He wrote a scheme, in which he grouped all mammals under the term ***uura***, and put this category on the same taxonomic level of ***uua***, ***ufu***, ***osa***. On the same one level he put the category ***baasi***. As a consequence ***aja-aa***, ***odi*** and ***uura*** *par excellence* became second level categories. He was a little embarassed by turtles, pangolins, aardvarks and flying squirrels. Lastly, he decided to put them into the ***uura*** *par excellence*, as a subcategory. It was exactly the system the anthropologists like. However, when I tested this scheme with other informants, they denied it firmly. Moreover, the same young man who had invented it never maintained that it was the Balese system, but only that it would have been a better one.

LITERATURE CITED

BERLIN, B., D. BREEDLOVE, and P. RAVEN. 1973. General Principles of Classification and Nomenclature. Amer. Anthrop. 75:214-242.

HALTENORTH, T., H. DILLER. 1980. A Field Guide to the Mammals of Africa. Collins, London.

HARAKO, R. 1977. The Mbuti as Hunters. Kioto Univ. African Studies 10:37-99.

HUNN, E. S. 1982. The Utilitarian Factor in Folk Biological Classification. Amer. Anthrop. 84:830-847.

MORRIS, B. 1976. Wither the Savage Mind? Notes on the Natural Taxonomies of a Hunting and Gathering People. Man 11:542-557.

SCHEBESTA, P. 1938-1950. Die Bambuti Pygmaeen vom Ituri. Memoires de l'Institut Colonial Belge. 3 vol.

VORBICHLER, A. 1965. Die Phonologie und Morphologie des Balese. Verlag J.J. Augustin, Gluckstadt.

__________. 1974. Das Interdialektale Sprachverhalten zwischen sesshaften Balese Hackbauern und nomadisierenden Efe-Pygmaeen. Anthropos. 69: 1-16.

NOTES

[1]The research took place in the framework of the Italian Ethnological Mission and was funded by the Italian Ministry for Foreign Affairs and by the Italian Ministry for Education.

[2]Kingwana does not maintain the distinction that Kiswahili does between ***mnyama*** (pl. ***wanyama***, big animals, both edible and inedible) and ***nyama*** (meat).

[3]Only one Efe informant told me that it could be used the term ***ogu***, but after he denied it. ***Ogu*** is the term used to indicate Coleoptera.

[4]Vorbichler (1965) reports the term ***bosa*** among the Southern Balese.

Book Review

The Origins of Agriculture: an evolutionary perspective. David Rindos. Orlando: Academic Press, 1984. $32.50.

Every once in a while a book appears which seems destined to spark controversy, stimulate imagination, and open the door to entirely new methods of analyzing vexing problems. Rindos' **The Origins of Agriculture** takes a bold stab at being such a book, and in many ways succeeds, although in other ways it falls short of being the definitive work on the subject.

In the introductory chapters, he critically reviews the literature concerning cultural evolution and the origin of agriculture, pointing out the Lamarckian and orthogenetic nature of many of the ideas in the literature. Next, he considers the "naturalness" of the human/plant relationship, comparing it to other mutualistic plant/animal interactions, such as the ant/acacia and ant/fungi symbioses, concentrating primarily on the changes in the defense and dispersal mechanisms of the plant. He then discusses in similar terms the different types of responses plants exhibit under various human utilization patterns, comparing seed harvest with the use of vegetative parts, and how these differences result from different selective pressures on the plant populations.

Rindos presents his own taxonomy of different types of domestication. First, there is "incidental domestication," which involves no alteration of natural dispersal patterns, but with humans being the effective but usually not the only agents of dispersal. This the author says is a conservative force serving to maintain existing subsistence patterns but which can set the stage for the origin of agriculture. Second is "specialized domestication," in which further evolution occurs solely within the developed agroecology. Throughout the book he stresses the distinction between "domestication," i.e. the establishment of mutualistic human/plant between "domestication," i.e. the establishment of mutualistic human/plant interactions, vs. "agriculture" i.e. the developed agroecology.

In the final two chapters, the author presents original mathematical models representing certain aspects of the origin, intensification, and spread of agriculture. The first is his "general model," a mathematical formulation involving such variables as contribution of domesticates to the diet, relative contribution of wild resources, and relative abundance of domesticates. The model makes several predictions: first, in the early stages involving primarily incidental domestication, increases in population would cause increases in environmental degradation, increases in population would cause increases in environmental degradation. There is a negative feedback restricting further population growth based on wild resources, but the demographic foundations are laid for the transition to specialized domestication. Second, in that transition stage, humans no longer select the best foods but feed on all available food types in proportion to their preceived abundance, increasing diet breadth. Third, the model predicts that domestication permits population increase.

Rindos then presents a second model, the "graphic model," in which he plots the relative value of each food type vs. the amount of each resource available, and uses this graph to make various predictions about diet breadth. In all of this, he makes the assumptions that animals are more highly valued as food sources than plants, wild plant resources are more abundant than those from animals, and domesticates arose from the less-valued components of the wild plant class.

Finally, he examines the effects that domestication has on population size. Any mutualistic interaction raises the carrying capacity of both species, and the human/plant relationship is no exception. Hence the increase in population is a result of the domestication rather than its cause. He argues further, reflecting ideas presented in an earlier paper (Rindos 1980), that the most *un*stable agricultural systems are the ones most likely to spread, since during bad years (assumed to be more common in unstable systems) people are more likely to emmigrate, taking their subsistence systems with them.

The book, although presenting numerous fascinating new hypotheses, is limited by several major drawbacks, primarily emanating from the author's preconceived biases toward his subject matter. Rindos is a devout Darwinian, almost to the point of religious fervor, and attempts to apply the theory of natural selection whenever possible, regardless of the applicability of the approach (see also Rindos 1985 and subsequent comments). His biases show through in other ways as well, for example in his closing statement when he justifies his interest in the origins of agriculture by likening agriculture to an infectious disease. The literature reviews, although extensive and clearly written, should be taken with a proverbial grain of salt, since the author frequently pooh-poohs any ideas at variance with his own. For example, he denigrates the idea that population pressure may have had a contributing role in the development of agriculture, as suggested by Boserup, Cohen, and several other workers, totally ignoring the possibility of a positive feedback mechanism relating population density and agricultural technology.

The models he proposes are only a first approximation of the kind which are needed for this kind of analysis. Any model is only as good as its assumptions, which must be rigorously tested against all the available evidence. Rindos makes liberal use of unsubstantiated assertions and tenuous if not erroneous assumptions concerning how a group of people would react in a given situation. The variables used in the models are also open to question; for example, in the discussion of his graphic model, he stresses that "value" should be defined not in terms of caloric content or other similar quantity but should instead reflect the "technology, preferences, and habits of a culture;" a "human-integrated perception of investment and return, availability, nutrition, and abundance." The use of such a nebulously defined variable runs the strong risk of giving rise to totally unfalsifiable hypotheses. There are many other aspects to the situation which could well yield fruitful areas of inquiry, including those involving dynamic processes internal to the human society, such as demographic, nutritional, and time allocation considerations.

Also missing is the application of a wide variety of models constructed for other ends but potentially shedding light on the problem at hand. There exist innumerable examples of mathematical formulations in ecology, economics, etc., which could be of tremendous assistance in some of the things Rindos is trying to do, but he ignores them, preferring to write his own models *a priori*. True, there is a danger in making too bold analogies (of which Rindos himself is guilty); but nor does it pay to spend a great deal of effort trying to reinvent the wheel.

I welcome the approach, and strongly recommend the book, with the appropriate caveats, to anyone interested in the subject. The book presents a bold, fascinating new look at a problem which has vexed workers in several academic fields for decades, and I anticipate that the types of methods used here will be of great value in uncovering heretofore unsuspected aspects of the situation. If it merely succeeds in provoking controversy and stimulating thought the book will have served its purpose admirably.

REFERENCES

Rindos, David (1980) Symbiosis, instability, and the origins and spread of agriculture: a new model. Current Anthropology 21(6):751-772.

Rindos, David (1985) Darwinian selection, symbolic variation, and the evolution of culture. Current Anthropology 26(1):65-88.

Joseph E. Laferriere
Department of Ecology & Evolutionary Biology
University of Arizona
Tucson, AZ 85721 USA

J. Ethnol. 5(1):31-47 Summer 1985

GATHERING AND SUBSISTENCE PATTERNS AMONG THE P'URHEPECHA INDIANS OF MEXICO[1]

JAVIER CABALLERO N.
CRISTINA MAPES S.
Jardin Botanico, Instituto de Biologia
Universidad Nacional Autonoma de Mexico
Ciudad Universitaria
Coyoacan 04510, Mexico, D.F.

ABSTRACT.–The P'urhepecha Indians, also known as "Tarascans" supplement their subsistence agriculture by gathering edible mushrooms and numerous vascular plants. In addition they collect honey produced by several species of wasps. Many species of plants are gathered for medicinal uses, firewood, ornaments or household needs. These plants are collected throughout the year from agricultural fields as well as from the natural environment. For the P'urhepecha, gathering is a part of a complex year round subsistence pattern based on multiple uses of their natural resources.

RESUMEN. La recolección es una práctica de gran importancia para la subsistencia entre los indios P'urhepecha, o Tarascos, del Lago de Patzcuaro, Michoacán, México. Ellos recolectan hongos, miel y larvas de ciertas especies de avispas, y numerosas plantas comestibles. De estas últimas, 36 especies son las mas importantes. Se recolectan tambien diversas especies de plantas con fines medicinales, para combustible, como adorno o para uso doméstico. La recolección se realiza tanto en el medio ambiente natural como en los campos cultivados en diferentes epocas del año.

Con base en los datos presentados, se discute el significado que tiene la recolección. Se plantea que la persistencia de esta práctica, mas que ser un síntoma de pobreza, es un rasgo propio de la cultura P'urhepecha. Se señala que la recolección es en realidad parte importante de un complejo patron de subsistencia basado en el uso múltiple de los recursos naturales.

INTRODUCTION

Studies of subsistence patterns in agricultural societies usually consider agriculture to be the only productive practice, giving too little attention to gathering, hunting and fishing. With the exception of works of Pennington (1963, 1968), Bye (1979), Messer (1978), Felger and Moser (1976), Wilken (1979), among others, the importance of gathering in past and present agrarian societies has not been seriously considered. However, even today, these practice activities are significant in terms of the amount and diversity of products for indigenous farmers in Mexico.

In this paper we describe the present role and patterns of gathering amoung the P'urhepecha[2] Indians, also known in the literature as the Tarascans. For these people, living in the Region of Lake Patzcuaro, in the Mexican state of Michoacan, gathering is part of a complex subsistence and plant use pattern based on multiple uses of their natural resources.

We report herein on a portion of the results of our multidisciplinary research project on traditional knowledge, use and management of natural resources in the Lake Patzcuaro basin. The majority of our field work was carried out between early 1978 and late 1980. Ethnobotanical data and voucher specimens were obtained in the field and market places with the aid of 50 native consultants. Herbarium specimens are deposited in the Herbario Nacional (MEXU) of the Instituto de Biologia, Universidad Nacional Autonoma de Mexico. Mexico.

THE SETTING

The Lake Patzcuaro Basin is one of the three regions that form the modern day geographic area of the P'urhepecha culture. In prehispanic times this region was the main center of the P'urhepecha empire. Despite the processes of social and cultural change, it is still one of the most extensive areas of indigenous culture in Mexico.

The study area (Figure 1), known as the Lake Patzcuaro Basin, is located in the Transverse Neovolcanic Belt, in the northern part of the state of Michoacan. It forms part of the lacustrine system which also includes the Valley of Mexico. The area is approximately 1,000 km^2 and ranges from 2,043 to 3,200 m in elevation, with five obvious physiographic zones: the islands in the lake, the shoreline, the hillsides, the intermountain valleys, and the mountains. The lake itself occupies about 100 km^2. The basin is bordered by high mountain ranges on the west, north and south. The geography of the area is discussed in detail by Barrerra (1985).

Although the climate is temperate (mean monthly temperature is 16°C), with mild winters, several degrees of below freezing temperatures often occur during December and January. A well-marked dry season extends from November to May, and the rainy season is from June to October. Annual precipitation is about 1,000 mm (see Garcia, 1973, for details of the climate).

In terms of the interelations between the people in the environment two major landscapes can be identified: the "natural" environment and the transformed or anthropogenic environment. Areas supporting primary and secondary vegetation are herein termed the natural environment. Forests are often dominated by oaks (*Quercus* spp.), pines (*Pinus* spp.), and fir (*Abies religiosa*) with intervening shurb and grasslands. The natural ecosystems of Lake Patzcuaro are represented by three communities of hydrophytes occurring in the characteristic Zonation in relation to the shoreline (Caballero et. al.

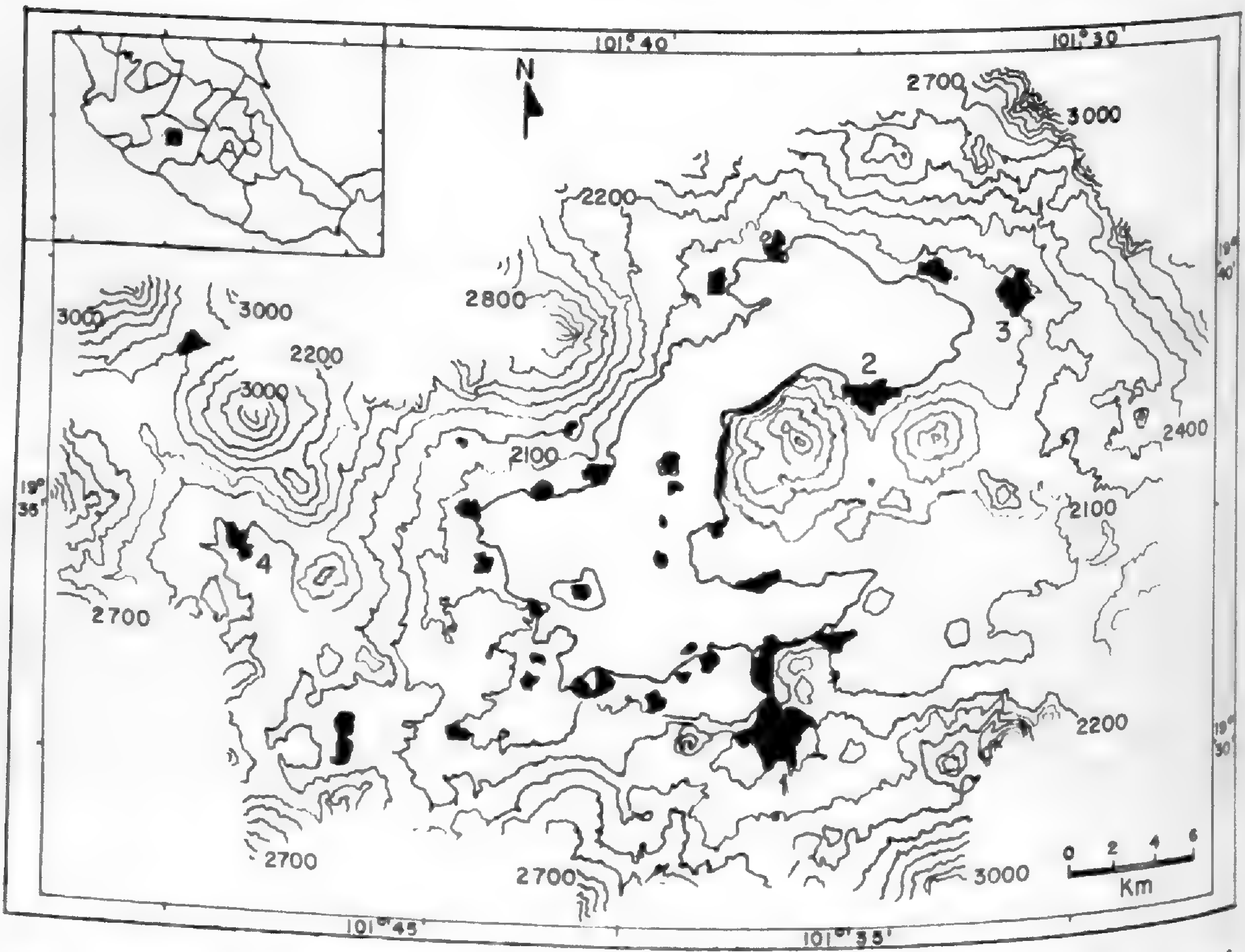


FIG. 1.–Lake Patzcuaro Basin (Based on Comision de Estudios del Territorio Nacional 1977, and Gorenstein and Pollard 1983), showing major settlements. 1 = Patzcuaro, 2 = Tzintzuntzan, 3 = Quiroga, 4 = Pichataro. Contour interval: 100 meters.

1981, Toledo et. al. 1980). We have recorded approximately 500 vascular plant species in the region, and estimate the total flora to include 600 to 700 species.

The transformed environment is made up of areas devoted to agriculture, cattle and human settlement. The population of nearly 80,000 inhabitants is distributed in about 100 towns and villages. The P'urhepecha population constitutes nearly 25% of the total and is located in all of these island, shore and mountain settlements.

P'URHEPECHA ECONOMY

The P'urhepecha economy is based on agriculture, fishing, and folk art (artesanias). Agriculture is the most important and widespread economic activity among the P'urhepecha. Almost all of the harvest—maize, beans, squash, and wheat—is for self-consumption. In addition to these common crops, 16 species and numerous varieties of fruit trees—mostly pears, apples, and peaches—are cultivated in kitchen gardens (Toledo, et. al., 1980). They cultivate fifteen species of vegetables near the lakeshore. Fishing is an important traditional activity and fourteen species of fish are obtained from the lake (Toledo, et. al., 1980). Animal husbandry is mostly limited to chickens and turkeys, although some people raise a few pigs. Most families have one or two oxen and a few families own a cow. Hunting, once an important activity, is no longer significant. Today it is restricted to squirrels, rabbits, and about eight species of migratory ducks (Foster, 1948). The most important folk arts are ceramics, weaving based on hydrophytes (*Scirpus* spp. and *Thypha* spp.), and many different wooden objects such as furniture, masks, kitchen utensils, and sculpture.

GATHERING

Patzcuaro Basin P'urhepecha use has been recorded for 224 species of wild native and naturalized vascular plants (Table 1). However, not all of these plants are currently gathered. Approximately 60 species, or 25% of the useful flora are commonly gathered, and these are mainly plants used for food and firewood. The majority of the 224 useful species have been used for medicinal purposes. Various plants are also gathered for ornamental use, fodder, and tool making which includes a variety of household utensils.

Gathering is usually carried out in association with agriculture, and is done mainly by the men although at times the women also participate. Every morning while walking to his parcel of land, the man takes note of things he will gather and carry back with him upon his return. In general these observations are made with no preconceived plan. In addition both men and women make special trips to gather teas and mushrooms to sell in markets, medicinal plants also to be sold in markets, and special foods for their own use which they consider to be delicacies.

EDIBLE PLANTS

Fruits and roots of certain plants are commonly eaten in the field as snacks or candies or to allay thirst, but are not brought home. These include the root of *Phaseolus heterophyllus* which is eaten like ***jicama*** (*Pachyrrizus erosus*) and *Solanum cardiophyllum* which has small tubers like common potato (the men stop to cook it in the field during their agricultural labors). The P'urhepecha have shown and told us about certain plants which they know to be edible but they do not gather or eat them.

TABLE 1.—*Plant uses in the Lake Patzcuaro Basin.*

Use	No. Species	Use	No. Species	Use	No. Species
Medicinal	99	Fodder	9	Toys	4
Food	30	Flavorings	7	Dye	3
Household Utensils	20	Construction	7	Poisons	3
Firewood	16	Tools	4	Insecticides	2
Ornament	12	Tannins	4	Magical, Religious	7

In general, wild edible plants are an important complement to the everyday diet, even though most of daily nutrition is provided by the products of agriculture: maize, beans, squash, and wheat. Collected plants are consumed mainly in the form of fruits, greens, and teas (Table 2). Mushrooms are an important input to the diet but only during the rainy season. Of the 43 species of fungi known to be eaten (Mapes et. al. 1981), only 10 are regularly gathered. These most highly esteemed species are gathered by the people for their own use and to sell in the markets. The P'urhepecha commonly consume these mushrooms in soups or cooked with "chiles" (*Capsicum annuum* and *C. pubescens*) and other spices and vegetables.

"Quelites," or greens, are among the more important food plants gathered in the region. As with the Tarahumara (Bye 1981), the *quelites* gathered used by the P'urhepecha are commonly associated with agriculture and anthropogenic vegetation. Also, as in the case of the Tarahumara, we believe that P'urhepecha *"quelites"* are undergoing active processes of domestication. Nine species are considered as *"quelites"* and are collectively called ***xakua*** in the P'urhepecha language (Table 2). Among their more important quelites are *Amaranthus hybridus*, *Brassica campestris*, and *Chenopodium berlandieri*. *"Quelites"* are usually cooked with *"chiles"* and mixed with fish, meat or beans.

Several species of plants provide sweets and condiments. For example the young inflorescence stalks of *Agave inaequidens* are collected in January and cooked and eaten as deserts. Plants used as condiments include *Tagetes micrantha* and two species of wild *Physalis.*

Commonly gathered fruits of arborescent species include *Crataegus pubescens, Morus microphylla, Opuntia* spp., and *Prunus serotina* spp. *capuli*. Among non-arborescent plants that provide fruit, the most important are *Gonolobus numularis* and *Rubus adenotrichos*. *Gonolobus* fruit, known as ***talayote***, is highly esteemed. It is toasted and then eaten.

FIREWOOD

The most important firewood trees (Table 3) are pines, oaks, and two species of alder (*Alnus*). Certain shrubs, such as *Baccharis conferta*, are also used as fuel. The selection of one or another species depends on the kind of fire desired and availability. For example, pine wood is used when an intense and fast-burning fire is needed, and oak or alder wood is used when a longer-lasting fire is desired.

Firewood for domestic consumption is usually gathered only from dead, fallen trunks and branches found on the forest floor; living branches and trees are not cut for domestic firewood. In contrast, there is intensive use of both living trees and dead wood for firing ovens for commercial bread and pottery making. This use is one of the most important causes of deforestation in the region and is responsible for the ever-increasing distances from the villages to the forests. Long walks are now required to obtain firewood.

MEDICINAL PLANTS

The major uses of medicinal plants are to prevent or cure illnesses of the digestive tract, respiratory system, female reproductive system, traumas, and various illnesses of domestic animals. Medicinal plants are also employed to cure supernatural illnesses such as ***susto*** (popular term used for an ailment provoked by a sudden-and disagreeable experience, Viesca et. al., 1976).

Clay (1981) pointed out four possibilities of medical choice in Pichataro, a mountain town in the Patzcuaro Basin, and the same conditions seem to hold true for the P'urhepecha in general. These alternatives are: (1) self treatment, (2) *curanderos* (folk healers or practitioners of folk medicine), (3) social service practitioners (*pasantes*. medical students fulfilling their social service obligation), and (4) physicians. These alternatives may represent consecutive steps in treating an illness. Treatment decision

TABLE 2.–*Common edible wild-gathered plants in the Lake Patzcuaro Basin. A = maize and wheat fields, and fallow fields, B = shrublands of Baccharis spp. (derived from pine/oak forests), G = grasslands with xerohpytic plants such as Acacia spp., and Opuntia spp., O = oak forests, P = pine forests, M = specimens collected only in markets.*

Type of Food and Species	Habitat	Months of Procurement
Fruits		
Casimiroa edulis	B	April-May
Crataegus pubescens	B, P	October-January
Gonolobus numularis	A	September-October
Jaltomata procumbens	A	August-October
Morus microphylla	B	June-August
Opuntia joconostle	G	October-January
Opuntia tomentosa	G	June-September
Prunus serotina	B, P	July-October
Rubus adenotrichos	B	March-May
Solanum mozinianum	A	July-October
Greens		
Amaranthus hybridus	A	March-July
Amaranthus sp.	A	March-July
Brassica campestris	A	May-September
Chenopodium berlandieri	A	March-June
Reseda luteola	A	January-May
Rumex crispus	A, G	January-December
Rumex conglomeratus	G	January-December
Sycios microphylla	A	August
Teas		
Agastache mexicana	P, O	May-November
Bidens ostruthoides	P, O	January-December
Hedeoma piperatum	P, O	September-October
Satureja laevigata	P, O	December-February
Sweets and Condiments		
Agave inaequidens	G, B	January
Physalis acuminata	A	March-December
Physalis pubescens	A	August-November
Tagetes micrantha	A, G	January-December
Mushrooms		
Agaricus campestris	P, B, G	June-November
Amanita caesarea	P, B	June-November
Armillariella tabescens	M	May-September
Boletus edulis	P, O	July-September
Calvatia cyathiformis	M	August-September
Helvella crispa	P, O	July-November
Laccaria laccata	P, O	August-October
Lyophyllum decastes	P, O	May-September
Ustilago maydis	A	August-October
Xerocomus spadiceus	P	July-September

TABLE 3.–*Firewood plants from the Lake Patzcuaro Basin.*

Alnus acuminata Subesp. *glabrata*	*Pinus pseudostrobus*
Alnus jorullensis	*Pinus teocote*
Baccharis conferta	*Quercus castanea*
Pinus lawsoni	*Quercus crassipes*
Pinus leiophylla	*Quercus laeta*
Pinus michoacana var. *cornuta*	*Quercus obtustata*
Pinus montezumae	*Quercus rugosa*

may depend on five criteria: (1) the seriousness of the illness, (2) the knowledge or availability of an appropriate home remedy, (3) faith in the effectiveness of folk treatment as opposed to modern medical treatment, (4) the expenses of each alternative, and (5) the availability of the different medical resources.

The first and second alternatives (self treatment and treatment by the curanderos) involve the use of wild-collected medicinal plants. Self treatment is generally a domestic routine in most households, and involves a basic set of plants. Almost all of these plants are collected when needed, by both men and women, in areas near their homes. However, in some cases medicinal plants are purchased at the market (*El Mercado*) at Patzcuaro. Some of these wild-collected and market-purchased plants are also widely used elsewhere in Mexico for the same purposes: common examples are *Gnaphalium* spp., *Sida rhombifolia*, and *Tagetes* spp. (Table 4). The majority of curanderos are men, and they almost always collect their own medicinal plants. They frequently store their plants in a dried form in order to have them on hand when needed.

ORNAMENTAL PLANTS

Gathering of ornamental, or decorative plants is a common activity. During civic religious celebrations, groups of people collect branches and flowers of several species to adorn churches and other public places. It is also commonplace among the P'urhepecha to decorate their homes with flowers which are almost always wild-gathered. Some of the most important wild ornamental plants are orchids, such as *Laelia* spp. and *Habenaria clypeata* (Table 4).

OTHER USES

The gathering of wild plants to make soap and a variety of household utensils (Table 4) has been declining in recent years. Nowadays most of the people prefer to purchase manufactured soaps and household utensils such as brooms. Nevertheless, the people recognize that using local plants is cheaper and usually more effective. On the other hand, gathering certain shrubs to make work implements, such as fish traps or cattle-herding poles, is still a common practice.

Although most of the plants gathered are destined for family consumption, there are some species which are collected in substantial quantity and sold in several regional markets. In some cases the P'urhepecha themselves sell these plants in markets as far away as Guadalajara and Mexico City. For the most part these are several fruits, such as *Crataegus pubescens*, *Prunus serotina*, and *Rubus adenotrichos* and certain teas, such as *Satureja laevigata* and to a lesser extent *Agastache mexicana*. The mushrooms often sold in these distant markets are *Amanita caesarea*, *Hypomyces lactifluorum*, *Ramaria flava*, and *Ustilago maydis*.

WASPS

The honey gathered from certain wasps is appreciated even more than honey from domestic bees. Wasp honey is eaten daily, and especially esteemed during the local

TABLE 4.–*Common non-edible gathered plants. A = maize and wheat fields and fallow fields, B = bushlands of Baccharis spp. (derived from pine/oak forests), F = fir forests, G = grasslands with xerophytic plants such as Acacia spp., and Opuntia spp., H = hydrophytes, O = oak forests, pine forests.*

Kind of Use	Species	Habitat
Medicines		
Febrifugues	*Artemisia mexicana*	B
	Bidens pilosa	B, G
	Chenopodium murale	A
Antidiarrheatics	*Cestrum nitidum*	P, O
	Lepechinia caulescens	P, B
	Sida rhombifolia	B, G
Antiespasmodics	*Tagetes lucida*	B, G
Cough drops	*Argemone ochroleuca*	A
	Cosmos bipinnatus	B
	Gnaphalium burgovii	B, G
Analgesics	*Montanoa grandiflora*	B
Alleviate liver sickness	*Berberis moranensis*	G
	Berula erecta	H
Alleviate kidney sickness	*Equisetum hymale*	H
	Eryngium carlinae	P
Ornaments		
to adorn homes	*Begonia gracilis*	B, O
	Bidens aequisquama	G, O
	Rumfordia floribunda	B, G
to decorate altars & churches	*Abies religiosa*	F
	Castilleja tenuifolia	G, B
	Habenaria clypeata	O
	Laelia grandiflora	O
Household Utensils		
soaps	*Michrosechium ruderale*	G, B
	Phytolacca icosandra	G, B
brooms	*Baccharis conferta*	B
	Heimia salicifolia	G, B
to wish dishes	*Erhetya mexicana*	G
	Salvia mexicana	B
Work Implements		
fish traps	*Ceanothus coeruleus*	B

fiestas (religious celebrations such as those dedicated to certain saints and weddings). We have identified two species of wasps which provide the P'urhepecha with honey: *Polybia occidentalis* subsep. *nigratella* Brysson, and *P. parvulina* Richards. In addition, the larvae of another wasp, *Vespula pensylvanica* Saussure, are gathered as a delicacy. This wasp makes subterrainean nests, locally called ***talpanales***, in the pine forest. Groups of people go to dig up the nests. This activity is a social event, similar to the collecting of ***talayote*** *(Gonolobus)* fruit. The larvae are taken home and toasted or cooked with *chile colorado* (red chile sauce).

GATHERING IN SPACE AND TIME

The P'urhepecha of the Lake Patzcuaro Basin collect products from the natural environment as much as from agricultural lands. The *milpas* (cultivated fields) and fallow fields provide the people with some of their most important food plants such as *quelites* (greens) as well as medicinal plants. These are mostly collected in maize fields but sometimes also may be taken from wheat fields. Shrub lands with *Baccharis* spp. and grasslands provide important fruits, e.g., *Crataegus pubescens, Gonolobus numularis, Opuntia* spp., *Prunus serotina* and *Rubus adenotrichos.* Oak and coniferous forests provide mushrooms, teas, and firewood. All of these plant communities provide medicinal plants, but on a comparative basis, the fallow fields and anthropogenic vegetation are the major sources of medicinal plants (Figure 2).

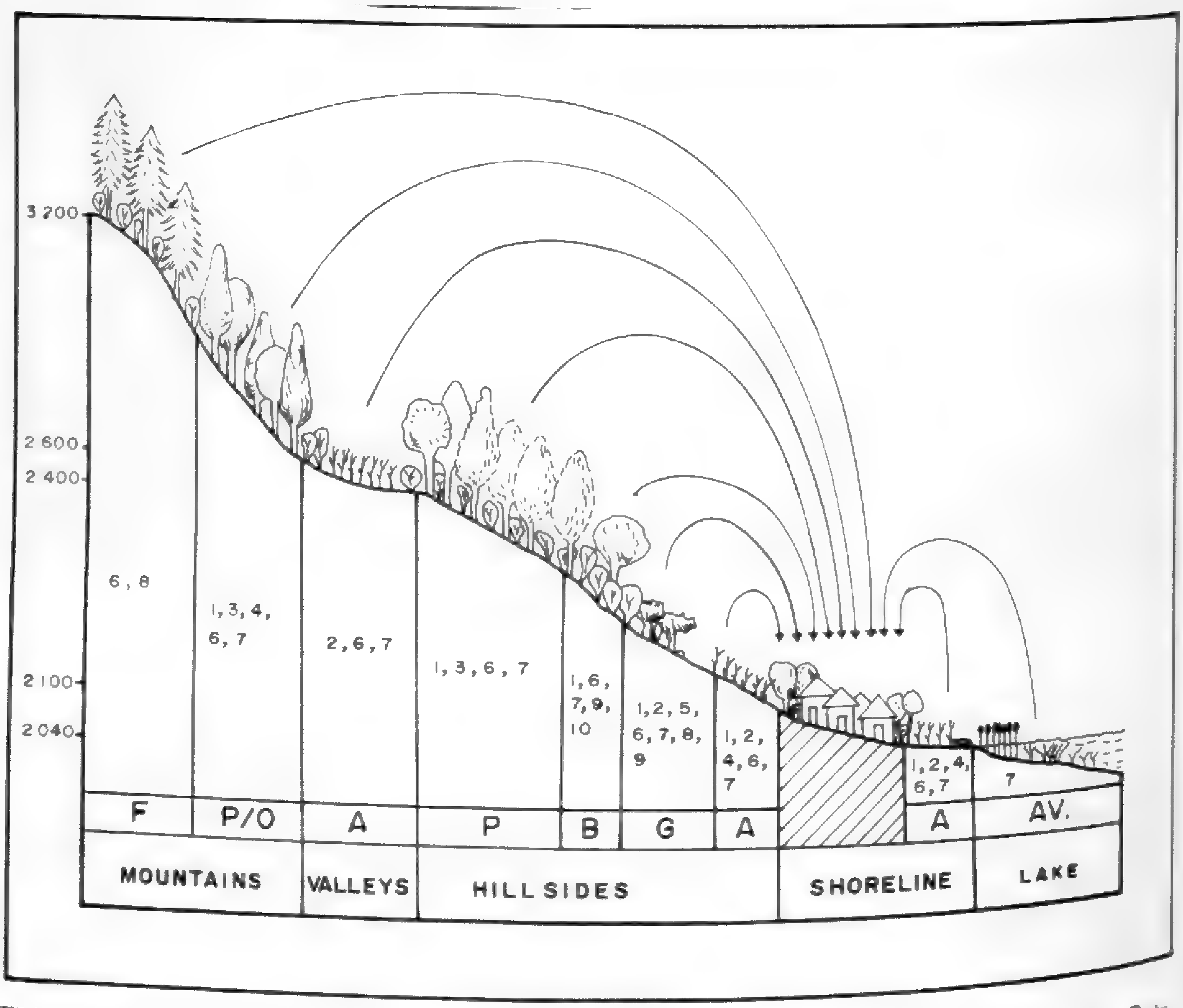


FIG. 2.–Profile showing origins of wild-gathered plants and products in the Lake Patzcuaro Basin. F = fir forest, P/O = pine, oak and mixed forests, A = maize and wheat fields, and fallow fields, P = pine forest, B = shrublands with *Baccharis* spp., G = grasslands with xerophytic plants such as *Acacia* and *Opuntia* spp., H = aquatic plant communities. 1 = fruits, 2 = greens, 3 = teas, 4 = condiments, 5 = sweets and condiments, 6 = mushrooms, 7 = medicinal plants, 8 = ornaments, 9 = household utensils, 10 = work implements.

The various wild-gathered plant products are available seasonally, and this is especially important in the case of the food plants. Almost all of the wild edible plants are gathered during the rainy season. There is an enormous variety and quantity of wild edible plants products available from July through September. The P'urhepecha say that during the rainy season there is such abundance of wild plant-derived food that it cannot all be used: *"es tanta la comida que hay que se desperdicia."* In contrast, during the dry season, from November through May and especially in January and February, the quantity of available wild food products is much less. Nevertheless, there are important dry season wild harvests, e.g., certain important teas such as *Satureja laevigata*, and edible fruits of *Casimiroa edulis*, *Crataegus pubescens*, and *Rubus adenotrichos*. The latter is available from the end of the dry season through the beginning of the rainy season (Figure 3). With the exception of these teas, wild-gathered edible plants are not stored.

On the other hand, medicinal plants and firewood are collected the year round. Some medicinal plants are stored dried for use when needed and plants for household and work implements are likewise often stored.

Various ornamental plants are available throughout the year. According to the date of the celebrations, there are specific flowers for each *fiesta*. For example, the beautiful orchid *Laelia autummalis* is the flower for the *"dia de muertos"* (Day of the Dead) in November, while *Laelia grandiflora* is one of the flowers for the *"fiesta de Corpus"* (Feast of Christ) in June.

THE SIGNIFICANCE OF GATHERING

Wilken (1969) pointed out that animal and plant gathering in the highlands of Mexico have commonly associated with poverty. Some anthropological studies of the P'urhepecha reaffirm this concept. Beals (1946) says that gathering is important only

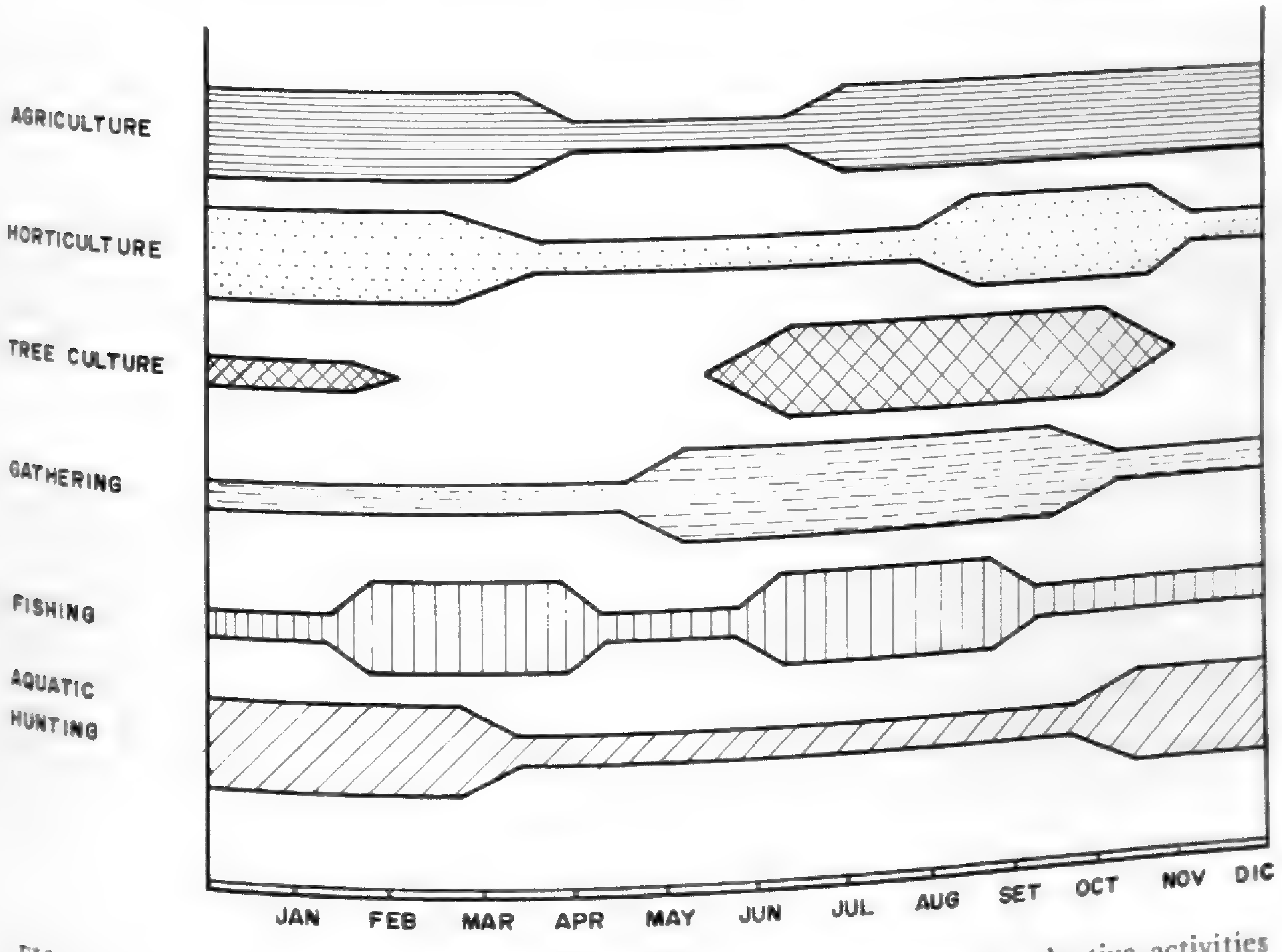


FIG. 3.–Availability of food products according to the different productive activities throughout the year. Thickness of the bars is diagramatic and not necessarily proportional to the amount of the production obtained.

in times of hunger or an an occassional practice to bring variety into the diet. Brand (1951) describes that use of more than 30 plant species for food, dying, household utensils and other different purposes. However, he states that these plants do not play an important role in the life of the majority of the people of the Municipio of Quiroga in the Patzcuaro Basin. Foster (1948) points out that at the time of his study gathering was not a significant economic activity at Tzintzuntzan due to the state progress reached by people.

Certainly in the region of Lake Patzcuaro the gathering of food plants and animals has a low prestige among the non-Indian population. Nevertheless, a remarkable persistence of this practice is observed among the P'urhepecha. There are several levels of significance of this practice to the life of the P'urhepecha. Of course, gathering provides fruit for emergency and during times of need or economic stress, wild plants have been a generalized source of food. Not only supplimentary foods have been obtained but also some substitutes for ordinary staples. The older men and women remember when they ate tortillas of maize mixed with acorns during the Mexican Revolution of 1910-1917. Today people say that they gather wild plants when there is nothing else to eat. However, in another sense, some people say that they gather plants or honey to give as gifts to friends at occassions of social events. As it is currently practiced, gathering affords a meaningful input to the agricultural subsistence. In addition to firewood and medicines, gathering provides dietary diversity.

Through the year, the primary dietary souces are maize in its multiple forms, beans and "*chile*". Secondarily, wheat is part of the basic diet. It is consumed as bread and sometimes mixed with maize and made into "*tortillas.*" These constitute the basic source of protein and energy. Protein is also obtained from fish from the lake and, to a lesser extent, by meat from chickens or pigs. At certain times of the year other cultivated plants, mainly 'squash' and some fruits, provide additional food, vitamins and minerals. In the lakeshore towns some vegetables are grown. Most of these, as well as most of the planted tree fruit crops, go to the market for sale. Thus, *quelites* and gathered fruits are the major source of vitamins and minerals essential for nutrition among the Purepecha.

Gathering provides foods mainly during the rainy season, from May through October (Figure 2). When these wild-harvested foods are combined with the other foods, a balanced nutrition may be achieved. The importance of the gathered plants lies not only in their intrinsic nutritional value, but also in their role in varying or relieving the monotony of the everyday staples. Wild edible plants are mixed and cooked with maize or beans and chile and sometimes are also combined with meat. As the different species of *quelites*, fruits, and mushrooms appear throughout the seasons, different dishes are prepared. Indeed, P'urhepecha cuisine is wonderfully attuned to the availability of the different wild resources through the year. Thus during the dry and hot season, one of the most common dishes is tamales of maize with "blackberry' (*Rubus adenotrichos*). These tamales are much appreciated because they are made with fresh ingredients. On the other hand, during winter, "*atole*" (gruel) with the chile and leaves of *Satureja laevigata* is commonly consumed. It has a good taste and warms the body. During the middle of the rainy season some of the common dishes are *quelites* or mushrooms cooked with beans or fish, as well as ***atole*** of unripe maize (green corn) or mushrooms cooked with beans or fish, and ***atole*** of unripe maize flavored with *Tagetes micrantha.*

The diversification of subsistence strategies is the underlying fact in the diversified nutrition. Toledo et. al. (1980) pointed out that in Patzcuaro as well as in many other peasant regions of Mexico, the Indian patterns of subsistence are based on the multiple use of the ecosystems. This results in the utilization of more than one ecosystem, the integration and combination of different practices, the multidimensionality of human activities, and the diversification of the products obtained from each ecosystem. This strategy may operate as much on the level of the family as at the level of the entire region. This pattern is carried out through time and space. On the spatial axis maximum utilization is sought of all of the available ecosystems. In terms of time, the goal is to obtain a maximum number of necessary products which each ecosystem offers throughout the year.

This diversified gathering strategy has formed the basis of the P'urhepecha society development since antiquity, as has been documented in the studies of Pollard (1982), Caballero (1982) and Gorenstein & Pollard (1983) on the protohistoric P'urhepecha (Tarascan) cultural system. Upon these basis gathering, as a forming part of a complex subsistence strategy, could be regarded as a practice that possesses a very long tradition.

Palynological or archeaological evidences for P'urhepecha plant gathering are lacking, and there are no clear references to plant gathering in historical documents such as the Relacion de Michoacan (1541) or the Relaciones Geograficas de la Diocesis de Michoacan (1579-1580). However, reports of use, consumption or economic exchange of non-cultivated plants does occur in these sources. Moreover, on the basis of the Relacion de Michoacan, Gorenstein and Pollard (1983) state that non-cultivated fruits such as ***capulin*** (*Prunus serotina*), ***tejocote*** (*Crataegus pubescens*), ***tunas*** (*Opuntia* spp.) and ***zapote blanco*** (*Casimiroa edulis*) formed part of the diet of the ancient P'urhepecha.

Quelites, or ***xakua***, have been to the P'urhepecha as the cultivated vegetables have been to the European culture. Although there are no specific references on their early use in the Lake Patzcuaro region, clear reports are provided for other areas. For example, in the Relaciones de Tuxpa and Jiquilpan (Relaciones geograficas de la Diocesis de Michoacan, 1579-1580) reports on consumption of quelites:

> "Las comidas de que antiguamente usaban dicen que eran de maiz y frijoles y benados y chile y muchos generos de yerbas cocidas."
>
> ". . . y la comida de ellos era tortillas, tamales, frijoles y otras yerbas de la tierra que se dicen quiletes."[4]

Gorenstein and Pollard (1983) identified ***xakua*** of the P'urhepecha region as *Chenopodium* spp. However, on the basis of our ethnobotanical field works it may be assumed that ***xakua***, or *quelites*, involves at least eight different species. There are many references to the collecting of firewood and use of non-cultivated medicinal plants in the Relacion de Michoacan and other sources such as the works of Francisco Hernandez (1959) and Fray Francisco Ximenez (1888). In the same way, oral tradition among the modern P'urhepecha suggests the past importance of plants for food and other purposes.

Indeed, the most significant features about gathering amonth the P'urhepecha are its antiquity and persistence. In general, this practice is declining in the Patzcuaro region because of cultural and socioeconomic changes. Habits for collecting certain plants and the ways of consumption are disappearing. For example, certain meals such as *"tamales"* with mushrooms or the *"atole"* with *"aguamiel"* (fresh unfermented *Agave* juice) which were common in the past are no longer prepared. Nevertheless, plant collecting is still a daily activity among the less acculturated P'urhepecha. Many P'urhepecha gather most of the non-cultivated plants resources mentioned in the historical documents and in the oral tradition. Moreover, at present, gathering of certain teas, fruits and mushrooms for sale at the markets is increasing.

Although, modern day gathering is normally associated with conditions of poverty (Wilken 1969), in the case of the P'urhepecha it is more closely associated with the persistence of a strong cultural tradition than to poverty. From the point of view of industrial society the P'urhepecha live in conditions of poverty. The use of wild plants for food and other basic needs has often been taken as clear evidence of poverty by European ethnocentric members and modern agroindustrial society. These processes must be critically considered in the light of integral man-nature relations from P'urhepecha culture of antiquity to the present day. The persistence of gathering throughout history is not an incidental fact! It corresponds to man-nature interaction which has proven its adequacy for thousands of years. The better understanding of the cultural, socioeconomic and biological factors involved in this process could form the basis for more rational use of natural resources by the present and future societies.

ACKNOWLEDGMENTS

We thank our P'urhepecha friends of the Lake Patzcuaro region for their hospitality, patient and generous assistance. This study was done as a part of the "Etnobiologia P'urhepecha del Lago de Patzcuaro" research project. We thank, too, the Direccion General de Culturas Populares, Subsecretaria de Cultura y Recreacion, Secretaria de Educacion Publica, of Mexico for financial support. The encouragement of anthropologist Leonel Duran was invaluable. We thank Drs. Robert Bye and Richard Felger for reading, commenting on and correcting the English version. We also thank Dr. Robert L. Jeanne from the Department of Entomology from the University of Wisconsin, Madison and Dr. O. W. Richards from London, England, for the identification of the wasp specimens collected for this study.

LITERATURE CITED

BARRERA, N. B. 1985. La Cuenca del Lago de Patzcuaro: Un analisis geosistemico. Manuscrito.

BEALS, R. 1946. Cheran: A Sierra Tarascan Village. Smithsonian Institution. Inst. Soc. Anthrop., publ. 2. Washington, D.C.

BRAND, D. 1951. Quiroga: A Mexican Municipio. Smithsonian Institution. Inst. Soc. Anthrop., publ. 11. Washington, D.C.

BYE, R. A. 1976. Ethnoecology of the Tarahumara of Chihuahua, Mexico. Unpubl. Ph.D. dissert. (Botany), Harvard Univ.

——————. 1981. Quelites -Ethnoecology of Edible Greens- Past, Present and Future. J. Ethnobiol. 1(1): 109-123.

CABALLERO, J. 1982. Notas sobre el uso de los recursos naturales entre los antiguos Purepecha. Biotica 7(1): 31-42.

——————, N. BARRERA, A. LOT, and C. MAPES. 1981. Excursion a la Cuenca de Patzcuaro. In: Guias Botanicas de Excursiones en Mexico. Sociedad Botanica de Mexico y Universidad Michoacana de San Nicolas de Hidalgo. Morelia: 78-119.

CLAY, J. Y. 1981. Medical choice in a Mexican village. Rutgers Univ. Press. New Jersey.

Comision de Estudios de Territorio Nacional. 1976. Carta topografica 1: 50,000, E14A21, E14A22, E14A31 and E14A32. Secretaria de Programacion y Presupuesto. Mexico.

FELGER, R. S. and M. B. MOSER. 1976. Seri Indian food plants: desert subsistence without agriculture. Ecol. Food and Nutrition. 5: 13-27.

FOSTER, G. M. 1948. Empire's Children: The People of Tzintzuntzan. Smithsonian Institution, Inst. Soc. Anthrop. Publ. 6:119.

GARCIA, E. 1971. Modificaciones al sistema de clasificacion Climatica de Köppen. Instituto de Geografia, Universidad Nacional Autonoma de Mexico. Mexico City.

GOMEZ, L. B., PEREZ, B. G., and ROJAS, I. H. ROJAS. 1984. Uandakua uenakua P'urhepecha jimbo (Introduccion al idioma P'urhepecha). Universidad Michoacana de San Nicolas de Hidalgo, Programa de Investigacion y Estudio de la Cultura P'urhepecha, y Direccion General de Investigacion Cientifica y Superacion Academica, S.E.P. Morelia, Mexico.

MAPES, C., G. GUZMAN, and J. CABALLERO. 1981. Etnomicologia Purepecha: el conocimiento y uso de los hongos en la Cuenca del Lago de Patzcuaro. Cuadernos de Etnociencia, num. 2. Direccion General de Culturas Populares, Secretaria de Educacion Publica and Sociedad Mexicana de Micologia, A.C., Mexico City.

LITERATURE CITED (continued)

MESSER, E. 1978. Zapotec plant knowledge: classification, uses and communication about plants in Mitla, Oaxaca, Mexico. Memoirs Museum of Anthropology, Univ. Michigan, 10, Part 2. Ann Arbor.

PENNINGTON, C. 1961. The Tarahumar of Mexico. Univ. Utah Press, Salt Lake City.

———. 1969. The Tepehuan of Chihuahua. Univ. Utah Press, Salt Lake City. 413 pp.

POLLARD, H. P. 1982. Ecological variation and economic exchange in the Tarascan State. Amer. Ethnol. 9(2):250-268.

Relaciones Geograficas (1579-1580). Relaciones Geograficas de la Diocesis de Michoacan. Jose Corona Nunez, ed. Coleccion Siglo XVI. Guadalajara.

Relacion de las Ceremonias y Ritos y Poblacion y Gobierno de Michoacan (1579-1580). 1977. Basal Editores. Morelia (Edicion Facsimilar).

TOLEDO, V. M., J. CABALLERO, C. MAPES, N. BARRERA, A. ARGUETA and M. A. NUNEZ. 1980. Los Purepechas de la Cuenca del Lago de Patzcuaro: una aproximacion ecologica. America Indigena 40(1):17-55.

VIESCA, C., P. LAMY, R. IBARRA and J. L. DIAZ. 1976. Terminos medicos asociados con plantas mexicanas. In: J. L. Diaz (ed.). Uso de las plantas medicinales de Mexico. Monografias Cientificas II. Instituto Mexicano para el Estudio de las Plantas Medicinales, A.C.:319-329.

WILKEN, G. 1969. The ecology of gathering in a Mexican farming region. Econ. Botany 24(3):286-295.

XIMENEZ, F. R. 1888. Cuatro libros de la naturaleza y virtudes medicinales de las plantas y animales de la Nueva Espana. Gobierno del Estado de Oaxaca, Oaxaca, Mexico.

NOTES

[1]An earlier version of this paper was presented by J. Caballero, C. Mapes and N. Barrera at the 3rd Conference of Ethnobiology in Tucson, Arizona in March 1981. The present paper is a revised and modified version of that presentation.

[2]The P'urhepecha names used in this paper are written phonetically according to the criteria of Gomez, Perez and Rojas (1984).

[3]It appears to be a common fact in all the Mesoamerican cultural area.

[4]"Foods that they were using, they say that they were maize and beans and deer and chile and many kinds of pot herbs." (Relacion de Tuxpa).

". . . and their foods were tortillas, tamales, beans and other herbs of the land that they name quiletes." (Relacion de Jiquilpan).

In the relation of Jiquilpan the word quelites was erroniously written as quiletes.

APPENDIX 1.–Vascular Plants utilized by the P'urhepecha in the Lake Patzcuaro Basin. 1 = species, 2 = family, 3 = life form, 4 = plant part utilized, 5 = P'urhepecha name, 6 = Spanish name, 7 = collection number. (J. Caballero & C. Mapes).

Abies religiosa H.B.K.; 2 - Pinaceae 3 - tree; 4 - leaves; 5 - ***kumcbkari***; 6 - oyamel; 7 - 648, 1009, 1102.

APPENDIX 1. (continued) – Vascular Plants utilized by the P'urhepecha in the Lake Patzcuaro Basin. 1 = species, 2 = family, 3 = life form, 4 = plant part utilized, 5 = P'urhepecha name, 6 = Spanish name, 7 = collection number. (J. Caballero & C. Mapes).

Agastache mexicana (Kunth.) Lint et Epling; 2 - Labiatae; 3 - shrub; 4 - leaves and flowers; 5 - ***tsimtsun tseraku***; 6 - toronjil morado, toronjil blanco; 7 - 1007, 1069, 1249.

Agave inaequidens Koch.; 2 - Agavaceae; 4 - floral peduncle; 5 - ***akamba***; 6 - maguey; 7 - 1034.

Alnus acuminata subesp *glabrata* (Fernald) Furlow; 2 - Betulaceae; 3 - tree; 4 - stems and branches; 5 - ***its'u pamu***; 6 - aile; 7 - 309, 1245.

Alnus jorullensis H.B.K.; 2 - Betulaceae 3 - tree; 4 - stems and branches; 5 - ***tepamu***; 6 - aile 7 - 85, 135, 158, 348.

Amaranthus hybridus L.; 2 - Amaranthaceae; 3 - herb; 4 - leaves and stems; 5 - ***kurintsi xakua***; 6 - quelite de cerdo; 7 - 674, 714, 785.

Amaranthus retroflexus L.; 2 - Amaranthaceae; 3 - herb; 4 - leaves and stems; 5 - ***kuchiri xakua***; 6 - quelite de cochino; 7 - 714.

Argemone ochroleuca L.; 2 - Papaveraceae; 3 - herb; 4 - flowers; 5 - ***xate***; 6 - chicalote; 7 - 205.

Artemisia mexicana Willd.; 2 - Compositae; 3 - herb; 4 - the whole plant; 5 - ***tsauangueni***; 7 - 995.

Baccharis conferta H.B.K.; 2 - Compositae 3 - shrub; 4 - branches; 5 - ***karatakua***; 6 - jara; 7 - 146, 865, 947.

Begonia gracilis H.B.K.; 2 - Begoniaceae; 3 - herb; 4 - flowers; 5 - ***kaxurakua***; 6 - sangre de doncella; 7 - 276, 307, 403.

Berberis moranensis Hebenstr. et. Ludw.; 2 - Berberidaceae; 3 - shurb; 4 - stems; 5 - ***tiripu***; 7 - 277, 837.

Berula erecta Huds. Cav.; 2 - Umbelliferae; 3 - hidrophyte; 4 - the whole plant; 5 - ***xurburbe***; 7 - 937.

Bidens aequisquama (Fer.) Scherff.; 2 - Compositae; 3 - herb; 4 - inflorescences; 5 - ***xarbikamata, andan***; 6 - aceitilla; 7 - 104, 489, 520, 776.

Bidens ostruthoides (DC.) Sch. Bip.; 2 - Compositae; 3 - herb; 4 - leaves and stems; 6 - te de lima; 7 - 646.

Bidens pilosa L.; 2 - Compositae; 3 - herb; 4 - the whole plant; 5 - ***ts'umu***; 6 - aceitilla; 7 - 639, 728.

Brassica campestris L.; 2 - Cruciferae; 3 - herb; 4 - leaves; 5 - ***nipajipikun mortansa***; 6 - mortanza, nabo; 7 - 35, 114, 325, 682, 787, 1113.

Casimiroa edulis Llave et lex; 2 - Rutaceae; 3 - tree; 4 - fruit; 5 - ***uruata***; 6 - zapote blanco; 7 - 421, 892.

Castilleja tenuifolia Mart & Gal; 2 - Scrophulariaceae; 3 - herb; 4 - aerial parts; 5 - ***charrangi***; 6 - flor de San Miguel; 7 - 667, 778.

Ceanothus coeruleus Lag.; 2 - Rhamnaceae; 3 - shrub; 4 - branches; 5 - ***charen, ticherin***; 6 - membriguillo; 7 - 345, 454, 578, 824, 1001.

Cestrum nitidum Mart & Gal; 2 - Solanaceae; 3 - shrub; 4 - leaves; 5 - ***xupian***; 6 - hediondilla; 7 - 1063, 1098.

Chenopodium berlandieri Moq.; 2 - Chenopodiaceae; 3 - herb; 4 - leaves; 5 - ***japujukakura xakua***; 7 - 979, 1117.

APPENDIX 1. (continued) – Vascular Plants utilized by the P'urhepecha in the Lake Patzcuaro Basin. 1 = species, 2 = family, 3 = life form, 4 = plant part utilized, 5 = P'urhepecha name, 6 = Spanish name, 7 = collection number. (J. Caballero & C. Mapes).

Chenopodium murale L.; 2 - Chenopodiaceae; 3 - herb; 4 - leaves; 5 - ***xakua turipiti***; 6 - quelite; 7 - 1263.

Cosmos bipinnatus Cav.; 2 - Compositae; 3 - herb; 4 - flower; 5 - ***xarhikamata***; 6 - girasol; 7 - 67, 718, 827.

Crataegus pubescens (H.B.K.) Steud.; 2 - Rosaceae; 3 - tree; 4 - fruits; 5 - ***karax***; 6 - tejocote; 7 - 63, 148, 783, 839, 928.

Ehretya mexicana Watson; 2 - Borraginaceae; 3 - tree; 4 - leaves; 5 - ***tuminix***; 6 - tumin; 7 - 840.

Equisetum hymale L.; 2 - Equisetaceae; 3 - hidrophyte; 4 - the whole plant; 5 - ***xurburhe***; 6 - cola de caballo; 7 - 593.

Eryngium carlinae Delar.; 2 - Umbelliferae 3 - herb; 4 - the whole plant; 5 - ***kuanas***; 6 - hierba del sapo; 7 - 254, 371, 803, 1251.

Gnaphalium burgovii Gray 2 - Compositae; 3 - herb; 4 - leaves; 6 - gordolobo; 7 - 711; C. Mapes 43.

Gonolobus numularis Hemsl.; 2 - Asclepiadace; 3 - vine; 4 - fruits; 6 - talayote; 7 - 1024.

Habenaria clypeata Lindl.; 2 - Orchidaceae 3 - herb; 4 - the whole plant; 5 - ***xanuata***; 6 - granizo; 7 - 503.

Hedeoma piperatum Benth.; 2 - Labiatae; 3 - herb; 4 - leaves and flowers; 5 - ***paraxuin***; 7 - C. Mapes 43.

Heimia salicifolia (H.B.K.) Link.; 2 - Lythraceae; 3 - shrub; 4 - branches; 5 - ***its'u tarimu***; 7 - 404.

Jaltomata procumbens (Cav.) J.L. Gentry 2 - Solanaceae; 3 - herb; 4 - fruit; 5 - ***potsekua***; 7 - 413.

Laelia grandiflora Lindl.; 2 - Orchidaceae; 3 - epiphyte; 4 - the whole plant; 5 - ***tsiktsiki its'umakua***; 6 - flor de Corpus; 7 - 1136.

Lepechinia caulescens (Ort.) Epling; 2 - Labiatae; 3 - herb; 4 - leaves or roots; 5 - ***xenxenekua***; 6 - sonajita; 7 - 502.

Microsechium ruderale Naud.; 2 - Cucurbitaceae; 3 - vine; 4 - roots; 5 - ***apopin***; 7 - C. Mapes 32.

Montanoa grandiflora Hemsl.; 2 - Compositae; 3 - shrub; 4 - leaves; 5 - ***parakua***; 6 - vara blanca; 7 - 618, 738.

Morus microphylla Buckl.; 2 - Moraceae; 3 - tree, 4 - fruit; 6 - mora; 7 - C. Mapes 502 (voucher specimen in alcohol).

Opuntia joconostle Weber in Diguet; 2 - Cactaceae; 4 - fruits; 6 - joconol; 7 - 1141.

Opuntia tomentosa Salm-Dyck; 2 - Cactaceae; 4 - fruits; 5 - ***pare charapiti***; 6 - tuna roja; 7 - 1139.

Phaseolus heterophyllus Willd.; 2 - Leguminosae; 3 - vine; 4 - roots; 5 - ***kuxturuxkua***; 6 - jicamita; 7 - 282.

Phytolacca icosandra L.; 2 - Phytolaccaceae; 3 - shrub; 4 - fruits; 5 - ***konguera***; 7 - 142, 392, 686.

Physalis acuminata Greenm.; 2 - Solanaceae; 3 - herb; 4 - fruits; 5 - ***chapindikua***; 6 - tomatillo; 7 - C. Mapes 45.

APPENDIX 1. (continued) — Vascular Plants utilized by the P'urhepecha in the Lake Patzcuaro Basin. 1 = species, 2 = family, 3 = life form, 4 = plant part utilized, 5 = P'urhepecha name, 6 = Spanish name, 7 = collection number. (J. Caballero & C. Mapes).

Physalis pubescens L.; 2 - Solanaceae; 3 - herb; 4 - fruits; 5 - ***toma***; 6 - miltomate; 7 - 1248.

Pinus lawsoni Roezl.; 2 - Pinaceae; 3 - tree; 4 - branches; 5 - ***pukuri aparikua***; 6 - pino ortiguillo; 7 - 130, 417, 991, 1181.

Pinus leiophylla Sch. et Cham.; 2 - Pinaceae; 3 - tree; 4 - branches; 5 - ***pukuri urus***; 6 - pino chino; 7 - 29, 79, 155, 208, 365, 804, 954.

Pinus michoacana var. *cornuta* Martinez, 2 - Pinaceae; 3 - tree; 4 - branches; 5 - ***pukuri tepajkua***; 6 - pino lacio; 7 - 78, 211, 366, 395.

Pinus montezumae lam.; 2 - Pinnaceae; 3 - tree; 4 - branches; 5 - *pukuri tepajkua*; 6 - pino lacio; 7 - 137, 182, 611, 929.

Pinus pseudostrobus Lindl.; 2 - Pinaceae; 3 - tree; 4 - branches; 5 - ***pukuri kansimbo***; 6 - pino lacio; 7 - 159, 212, 367, 616, 927.

Pinus teocote Schl. et Cham.; 2 - Pinaceae; 3 - tree; 4 - branches; 5 - ***pukuri aparikua***; 6 - pino ortiguillo; 7 - 18, 31, 71, 384, 546, 638, 954.

Prunus serotina subesp. *capuli* (Cav.) Mc Vaugh; 2 - Rosaceae; 3 - tree; 4 - fruits; 5 - ***xengua***; 6 - capulin; 7 - 125, 133, 157.

Quercus castanea Nee; 2 - Fagaceae; 3 - tree; 4 - branches; 5 - ***urikua urapiti***; 6 - encino blanco; 7 - 64, 115, 269, 353, 481, 505, 700, 805, 1169.

Quercus crassipes H. et B.; 2 - Fagaceae; 3 - tree; 4 - branches; 5 - ***urikua tsirapsi***; 6 - encino chililllo; 7 - 74, 354, 561, 658, 911.

Quercus laeta Liebm.; 2 - Fagaceae; 3- tree; 4 - branches; 5 - ***urikua urapiti***; 6 - encino blanco; 7 - 171, 270, 356, 483, 627.

Quercus obtusata H. et B.; 2 - Fagaceae; 3 - tree; 4 - branches and wood; 5 - ***urikua tukus***; 6 - encino tukus; 7 - 46, 152, 218, 390, 492, 801, 1175.

Quercus rugosa Nee; 2 - Fagaceae; 3 - tree; 4 - branches; 5 - ***urikua turipiti***; 6 - encino prieto; 7 - 73, 163, 271, 355, 582, 656, 825, 958.

Reseda luteola L.; 2 - Resedaceae; 3 - herb; 4 - aerial parts; 5 - ***kuaranikua ts'pambiti***; 7 - 881.

Rubus adenotrichos Cham et Schl.; 2 - Rosaceae; 3 - vine; 4 - fruits; 5 - ***situni***; 6 - zarzamora; 7 - 134, 774.

Rumex crispus L.; 2 - Polygonaceae; 3 - shrub; 4 - leaves; 5 - ***pupurajkura***; 6 - lengua de vaca; 7 - 812, 1111, 1119.

Rumex conglomeratus Murr.; 2 - Polygonaceae; 3 - shrub; 4 - leaves; 5 - ***kuablanikua***; 7 - 887.

Rumfordia floribunda DC.; 2 - Compositae; 3 - shrub; 4 - inflorescences; 5 - *ts'ikts'iki melonixh*; 7 - 651, 1008, 1131.

Salvia mexicana L.; 2 - Labiatae; 3 - herb; 4 - leaves; 5 - ***cbarajkukua***; 6 - chia; 7 - 320, 432, 539, 663, 710, 838, 1075.

Satureja laevigata Standl.; 2 - Labiatae; 3 - shrub; 4 - leaves, flowers and branches; 5 - ***nurbiteni***; 6 - te nurite, te de monte; 7 - 585, 828, 859.

Sida rhombifolia L.; 2 - Malvaceae; 3 - shrub; 4 - leaves; 5 - ***itskipin***; 7 - 447, 537, 66, 726, 878.

APPENDIX 1. (continued) — Vascular Plants utilized by the P'urhepecha in the Lake Patzcuaro Basin. 1 = species, 2 = family, 3 = life form, 4 = plant part utilized, 5 = P'urhepecha name, 6 = Spanish name, 7 = collection number. (J. Caballero & C. Mapes).

Solanum cardiophyllum Lindl.; 2 - Solanaceae; 3 - herb; 4 - tubers; 5 - ***papax***; 6 - papa cimarrona; 7 - 1019.

Solanum mocinianum Dun.; 2 - Solanaceae; 3 - herb; 4 - fruits; 5 - ***pachindikua***; 6 - bebere gato; 7 - C. Mapes 23.

Sycios microphylla H.B.K.; 2 - Cucurbitaceae; 3 - vine; 4 - leaves; 5 - ***akarheni***; 6 - chayotillo; 7 - C. Mapes 1.

Tagetes lucida Cav.; 2 - Compositae; 3 - herb; 4 - aerial parts; 5 - ***kurujkumin***; 6 - Santa Maria; 7 - 80, 378, 499, 754, 902, 1029, 1205.

Tagetes micrantha Cav.; 2 - Compositae; 3 - herb; 4 - leaves; 5 - ***putsuti***; 6 - anis; 7 - 770, 790.

APPENDIX 2.—Fungi used for food by the P'urhepecha in the Lake Patzcuaro Basin. 1 = species, 2 = P'urhepecha name, 3 = Spanish name, 4 = collection number. (C. Mapes, deposited in the Herbarium of the Escuela Nacional de Ciencias Biologicas of the Instituto Politecnico Nacional, ENCB).

Ascomycetes

Hypocreales

Hypomyces lactiflorum (SCW. ex Fr.) Tul; 2 - ***kuxtereko***; 3 - trompa de puerco.

Pezizales

Helvella crispa Scop. ex Fr.; 2 - ***sirat angants urapiti***; 3 - oreja de raton blanca; 4 - 26, 29.

Basidiomycetes

Ustilaginales

Ustilago maydis (DC.) Corda; 2 - ***t'ukuru***; 3 - viejito; 4 - 97.

Hymenomycetes

Aphyllophorales

Clavariaceae

Ramaria flava (Fr.) Quel.; 2 - ***k'uin ants'ir terekua***; 3 - patita de pajaro; 4 - 27, 28.

Agaricales

Tricholomataceae

Armillariella tabescens (Scop. ex Fr.) Sing; 2 - ***paxakua***; 3 - montoncito; 4 - 95.

Lacaria laccata (Scop. ex Fr.) Berk & Br.; 3 - sikitereko; 4 - 96.

Lyophyllum decastes (Fr.) Sing.; 2 - ***parakua***; 3 - montoncito; 4 - 3.

Amanitaceae

Amanita caesarea (Scop. ex Fr.) Grev.; 2 - ***tiripiti terekua***; 3 - hongo amarillo; 4 - 14, 23, 24, 78.

Agaricaceae

Agaricus campestris L. ex Fr.; 2 - ***tepajkua terekua***; 3 - llanero; 4 - 117, 121.

Boletaceae

Boletus edulis Bull. ex Fr.; 2 - ***semitu***; 3 - semitas; 4 - 46.

Xerocomus spadiceus (Fr.) Quel.; 3 - hongo de paderon; 4 - 12.

Gasteromycetes

Lycoperdales

Calvatia cyathiformis (Bosc.) Morgan; 2 - ***patarata***; 4 - 118.

Book Review

The Analysis of Prehistoric Diets. Edited by Robert I. Gilbert, Jr. and James H. Mielke. 456 pp., illus. Academic Press, Orlando. 1985. $65.00.

The Analysis of Prehistoric Diets is another volume in the **Studies of Archaeology** series published by Academic Press. It is designed to summarize the various techniques which the archaeologist can use to reconstruct prehistoric food collection, processing, consumption and the health factors which may be linked with dietary conditions. It provides a useful review of the current "state of the art" in this field. The extensive bibliographies included at the end of each chapter make an excellent starting point for those interested in further research.

There is a basic division of the volume between the artifactual data and the human skeletal data. The preservation of faunal and floral remains is handled by Victor Carbone and Bennie C. Keel and includes a discussion on the various factors which lead to differential decay rates. Animal bone and botanical remains are also treated separately by Paul W. Parmalee and C. Earle Smith, Jr. respectively. Care is given to include detailed information on recovery, processing, analysis and interpretation of these remains. Gary F. Fry's section covers coprolite analysis and how this relates to dietary interpretation. Also included is an extensive review of parasite analysis and the biases which must be considered in interpreting this data.

The section on human skeletal material begins with a discussion by William Stini of growth and development and the physiological factors which strongly influence the adult human form. Although this may not be directly applicable to the archaeological record, an understanding of the complexity and adaptability of the human skeleton in its response to the environment is an asset. Separate chapters follow on skeletal pathologies (Harris lines and porotic hyperostosis) by Debra L. Martin et al., on developmental abnormalities in dentition (enamel hypoplasias and Wilson bands) by Jerome C. Rose et al., and on the incidence of dental caries by Mary Lucas Powell. A review of trace elements in human skeletal material by Robert I. Gilbert does more to convey the complexity of the issue than provide a simplified summary. This is frustrating but probably a more accurate view than normally presented in a volume of this nature. The osteological section ends with a fairly complete review by Jane Buikstra and James Mielke of the use of a skeletal series in the reconstruction of a demographic profile and how this can reflect the overall health of a population. Basic techniques such as sex and age determination are covered as well as the statistical analyses of mortality patterning.

Models appropriate for use in dietary reconstruction are included in various chapters throughout the volume. Bonnie W. Styles presents a chapter on the use of food resource availability for predicting diets within catchment areas and for intersite comparisons. Linear programming models are discussed in a chapter by Arthur S. Keene. While these cannot be applied directly to the archaeological setting, they can provide the archaeologist with important guidelines for understanding nutritional problems in terms of the costs and benefits to prehistoric populations. This volume concludes with a discussion of ethnographic inference and analogy by Mark P. Leone and Ann M. Palkovich.

The Analysis of Prehistoric Diets, while providing a comprehensive survey of current methodology in data collection and interpretation, does not break new ground. Despite its recent publication date some areas are already in need of amendment. Furthermore its $65.00 price tag places it beyond the reach of most students, for whom it would be most useful, and restricts its acquisition largely to libraries.

Alison Galloway
Human Identification Laboratory
University of Arizona
Tucson, Arizona

Book Review

Sustaining Tomorrow—A Strategy for World Conservation and Development. Francis R. Thibodeau and Hermann H. Field (Ed.). University Press of New England (Published for Tufts University), Hanover, N.H. & London (1984). Pp. xii + 196. $22.50 (cloth), $12.50 (paper).

There is today a plethora of publications on conservation and allied topics. Few there are that merit serious consideration, and many are doing *bona fide* conservation efforts a disservice. Here is a book, written by 19 specialists, that will, if widely distributed and read, most certainly enhance the numerous serious efforts underway towards conservation of nature's bounty.

The foreword by Harold Coolidge, one of the stars of serious conservation activities, and Honourary President, IUCN, is a masterpiece. The introduction, Section 1, comprises two chapters: "The World Conservation Strategy" by L.M. Talbot and An Introduction to World Conservation" by R. Dasmann.

These follow 12 intensely pertinent contributions: Section II, Conservation Objectives: 1) Ecological Processes and Life Support Systems (G.A. Betrand). 2) Preservation of Genetic Diversity (F. Wayne King); 3) Sustainable Use of Species and Ecosystems (G. Budowski). Priorities for National Action: III, 1) National and Regional Conservation Strategies (K.R. Moller); 2) Environmental and Planning and Rational Use (P. Jacobs); 3) Environmental Planning and Rational Use; 4) Building Support for Environmental (W.) Education; 5) Conservation-based Rural Development (D. Western). IV. Priorities for International Action: 1) Environmental Policy and Law (W. Burhenne, Alexandre Kiss and Malcolm Forster, 2) Management of the Global Commons (A. Hollick), 3) Tropical Forests and Genetic Resource areas (T. Lovejoy and A.R. Brash), 4) Regional Strategies for Managing the Oceans (S. Holt), and Food, Nutrition and Population (J. Mayer). There is a fifth illuminating contribution by J.C. Faby entitled Toward Sustainable Development. Sections on abbreviations and contributors as well as a bibliography of 170 items and a full index are appended.

Since conservation must be considered an integral part of economic botany, it is imperative that this new and searching contribution be brought to the attention of students and investigators in this interdisciplinary field of the plant sciences.

Richard Evans Schultes
Botanical Museum
Harvard University
Cambridge, Massachusetts

Tree Root Systems and their Mycorrhizas. D. Atkinson, K.K.S. Bhat, M.P. Coutts, P.A. Mason and D.J. Read (Eds.). Martinus Nijhoff/Dr. W. Junk, Publishers, The Hague (Kleuver Academic Publishers Group, Dordrecht) Holland (1983). Pp. ix + 525, fig. $Dfl. 165 (approximately $66.00).

Consisting of many contributions presented at a meeting of the International Union of Forestry Research Organizations in 1982, a meeting dedicated to tree root systems and their mycorrhizae, this volume will be of immediate interest to a large number of specialists concerned with the broad field of economic botany.

The papers are divided into two wide areas: 1) the development of the root systems of fruit and forest trees, their distribution through the soil and underground productivity; 2) the physiology, structure and epidemiology of infection of roots with mycorrhizae and studies of artificial innoculation. The book helps to fill in a gap between what is known from field and laboratory experiments and the practical information required by those constructing models simulating infection and functioning. There is a total of 59 papers by a large number of specialists from numerous countries. Each paper is provided with its own often extensive bibliography and an abstract. A detailed index makes the mass of material presented easily available to the reader or consultant.

One of the remarkable aspects in the publication of this volume is the rapidity in which it appeared—in less than a year following the meeting!

When the high quality of publications and the vast amount of material unavailable elsewhere except in institutions with extensive library facilities are considered, the price is very reasonable in today's market.

Richard Evans Schultes
Botanical Museum
Harvard University
Cambridge, Massachusetts

Blackmore, Vivian (compiler) (1984) **Why corn is golden: stories about plants.** Boston & Toronto: Little, Brown & Co. Cloth, 48 pp., $12.95.

(1981) **El maiz tiene color de oro: leyendas vegetales.** Mexico, D. F.: Editorial Novaro. (Distributed in U.S. by French & Spanish Book Corp., New York & Los Angeles). Cloth, 48 pp., $18.50.

If ethnobotany is defined to include folktales about plants then certainly this pair of books, one in English and one in Spanish, is a welcome albiet brief addition to the literature. Written in the form of children's books, they include six traditional Mexican folktales about such subjects as how sunflowers came to exist, why corn is golden, and how a certain people foiled a group of invaders by causing chocolate they had eaten to turn into stones. The books also contain six riddles concerning plants. The English translation is rather good, being relatively faithful to the spirit of the original (except for the riddles). The book is also furnished with large, beautiful watercolor illustrations.

From the perspective of a professional ethnobotanist, it is frustrating that the plants mentioned are not identified, especially in the first story, about how a certain plant obtained the name *Guie'tiiki,* and that the editors are not more explicit concerning the sources of the stories. However, the primary stated purpose of the books is not to communicate information to professionals but rather to amuse children and to educate them about other cultures. To this end they appear rather successful. It would have been wise to include a brief background chapter explaining a little about the cultures from which these stories arose, in particular concerning the religions of the pre-Spanish peoples, which receive prominent attention in several of the stories. Without this, I feel that much of the beauty and deeper meaning of the stories will be lost on the average American child. I also think the choice of material is a little too broad—some from Aztec times, others from contemporary Mexican experience—lending a certain unfocused character to the collection which may confuse some young readers.

Nevertheless, they are delightful books, which would make colorful additions to any children's library.

Joseph E. Laferriere
Department of Ecology & Environmental Biology
University of Arizona
Tucson, Arizona 85721

J. Ethnobiol. 5(1):51-58 Summer 1985

COTTONTAIL SPECIES IDENTIFICATION: ZOOARCHAEOLOGICAL USE OF MANDIBULAR MEASUREMENTS

SARAH W. NEUSIUS
Center for Archaeological Investigations
Southern Illinois University
Carbondale, IL 62901

PATRICIA R. FLINT
Flint Research Associates & Anasazi Heritage Center
Dolores, CO 81323

ABSTRACT.–It has been suggested that archaeologically recovered cottontail mandibles may be identified to species by examining the relationship between mandibular depth and alveolar length even though most of the cottontail skeleton is not diagnostic to species. Study of cottontail mandibles recovered by the Dolores Archaeological Program from Anasazi sites in southwestern Colorado has supported this suggestion but indicated that reliable species identification requires a more thorough analysis of traits. Further investigations should be directed to the topic of subspecific variation as well.

INTRODUCTION

Although the skeletal remains of cottontail rabbits commonly are recovered from archaeological sites (e.g. Bertram and Draper 1983, Binford et al. 1983, Cordell 1977), osteological separation of these cottontail species seldom is possible. Findley et al. (1975:83-86) have noted that the taxonomic relationships between the eastern cottontail *(Sylvilagus floridanus)*, the mountain or Nuttall's cottontail *(Sylvilagus nuttallii)*, and the desert cottontail *(Sylvilagus audubonii)* require further clarification, at least in New Mexico. Nevertheless, these authors have suggested that mandibular and dental characters can be used to separate the desert cottontail from the other two species even in archaeological and fossil materials. These characters, particularly mandibular measurements, have been used in several zooarchaeological analyses of cottontail remains to determine the species represented (Akins 1984; Anderson 1980; Harris 1963, 1970; Pippin 1979). This article indicates that the identification of cottontails is not necessarily as straightforward a matter as suggested by Findley and his coworkers.

The bones of cottontail rabbits occur more frequently in sites excavated by the Dolores Archaeological Program[1] than those of any other single taxon (Neusius 1985). For this reason alone it was considered desirable to determine the cottontail species represented. However, because there was reason to expect both desert and Nuttall's cottontail[2] to be present and because the habitat preferences of these species were known to differ (Armstrong 1972:82, 85; Bissell and Dillon 1982:7), further study of the Dolores cottontail remains promised to provide insights into Anasazi exploitation strategies (Flint and Neusius in press). Thus, we used the characters suggested by Findley and his coworkers to assign cottontail mandibles recovered at Dolores to species. We found the use of bivariate plots less than satisfactory because the accuracy of species identification is not evident. While the use of discriminant analysis was more satisfactory for our purposes, this approach suggested that the proper identification of cottontail mandibles is a more complex task than anticipated and deserving of further study.

SPECIES DETERMINATIONS USING BIVARIATE PLOTS

According to Findley et al. (1975:84-85) the desert cottontail has a deeper jaw and a shorter toothrow than either the Nuttall's or the eastern cottontail. The characters used to measure this are the alveolar length and the depth of the lower jaw (Fig. 1). Alveolar length is defined as the distance between the anterior margin of the third premolar and the posterior margin of the third molar. However, these authors suggest that the distance between the anterior border of P_3 and the posterior margin of M_1 will suffice in studies of archaeological and fossil material. Mandibular depth is defined as the distance between the anterior border of the fourth premolar and the ventral border of the mandible at right angles to the toothrow.

Dental characteristics also may be useful in identifying cottontail species according to Findley and his coworkers. The borders of the desert cottontail's posterior external reentrant angle on premolar 3 are strongly crenulated, while those of the eastern cottontail are less crenulated and those of Nuttall's cottontail are smooth (Findley et al. 1975: 85-86).[3]

In the Dolores study osteological measurements were made on 302 cottontail mandibles from 27 archaeological sites located in the Dolores project area. Nineteen of these apparently were from juvenile individuals, and these were omitted in the subsequent analysis.

The measurements taken followed those recommended by Findley and his coworkers. As shown in Figure 1, distance A is the depth of the jaw, measured with a vernier calipers. In order to standardize this measurement, the mandible was placed on graph paper with the cheektooth row aligned vertically and the labial side up. The stationary part of the calipers then was placed on the most anterior portion of the alveolar notch between P_4 and P_3 and the sliding portion was brought to the basal border of the mandible at a right angle to the aligned cheektooth row. However, the development of the ridge of bone at the anterior alveolar notch is variable and the area may be eroded in archaeological specimens. As with all our measurements we attempted to be as consistent as possible in locating this point. Distance B is the length of the toothrow. The

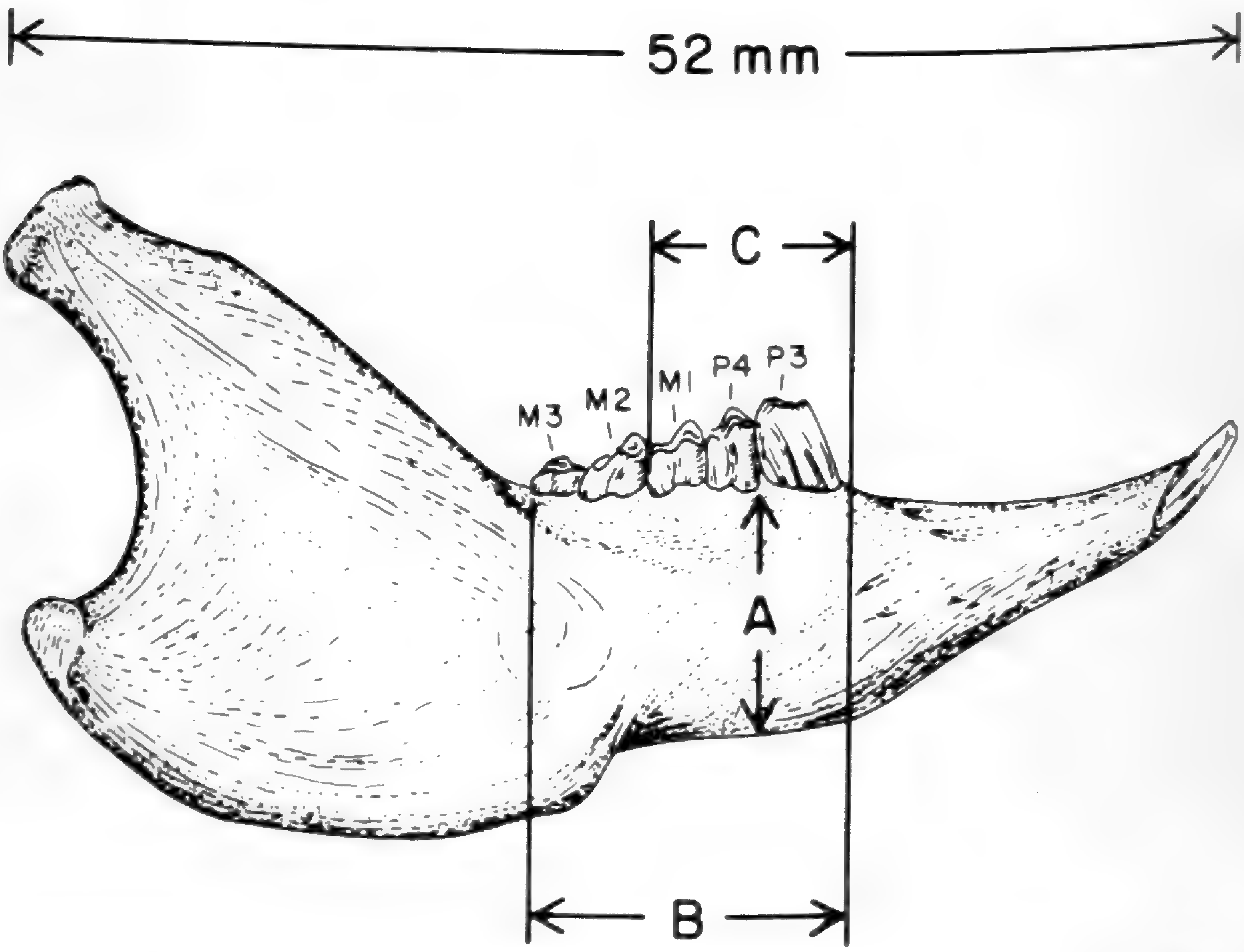


FIG. 1.–*Osteological distance on the cottontail mandible. Distance A is the depth of the mandible. Distance B is the alveolar length (P_3-M_3) and distance C is a modified alveolar length (P_3-M_1).*

measurement was taken with the calipers from the anterior alveolar notch of the third premolar to the posterior alveolar notch of the third molar. Distance C is the modified alveolar length recommended for archaeological materials. The calipers were set at the anterior alveolar notch of the third premolar and expanded to the posterior notch of the first molar in order to obtain this measurement. In our study, sample size was increased by 27 when mandibles for which only distances A and C could be measured were added.

The crenulation of the enamel border of the third premolar also was examined. Using a 10 power magnifying lens, a subjective evaluation was made on a scale of 0 to 3 with 3 assigned to very-, 2 to somewhat-, 1 to slightly crenulated, and 0 to uncrenulated specimens.

In order to classify these specimens each mandible for which distance B was present was plotted on a scattergram (Fig. 2). Mandibular depth was measured along the x-axis and alveolar length (P3-M4) was measured on the y-axis. An approximation of the line

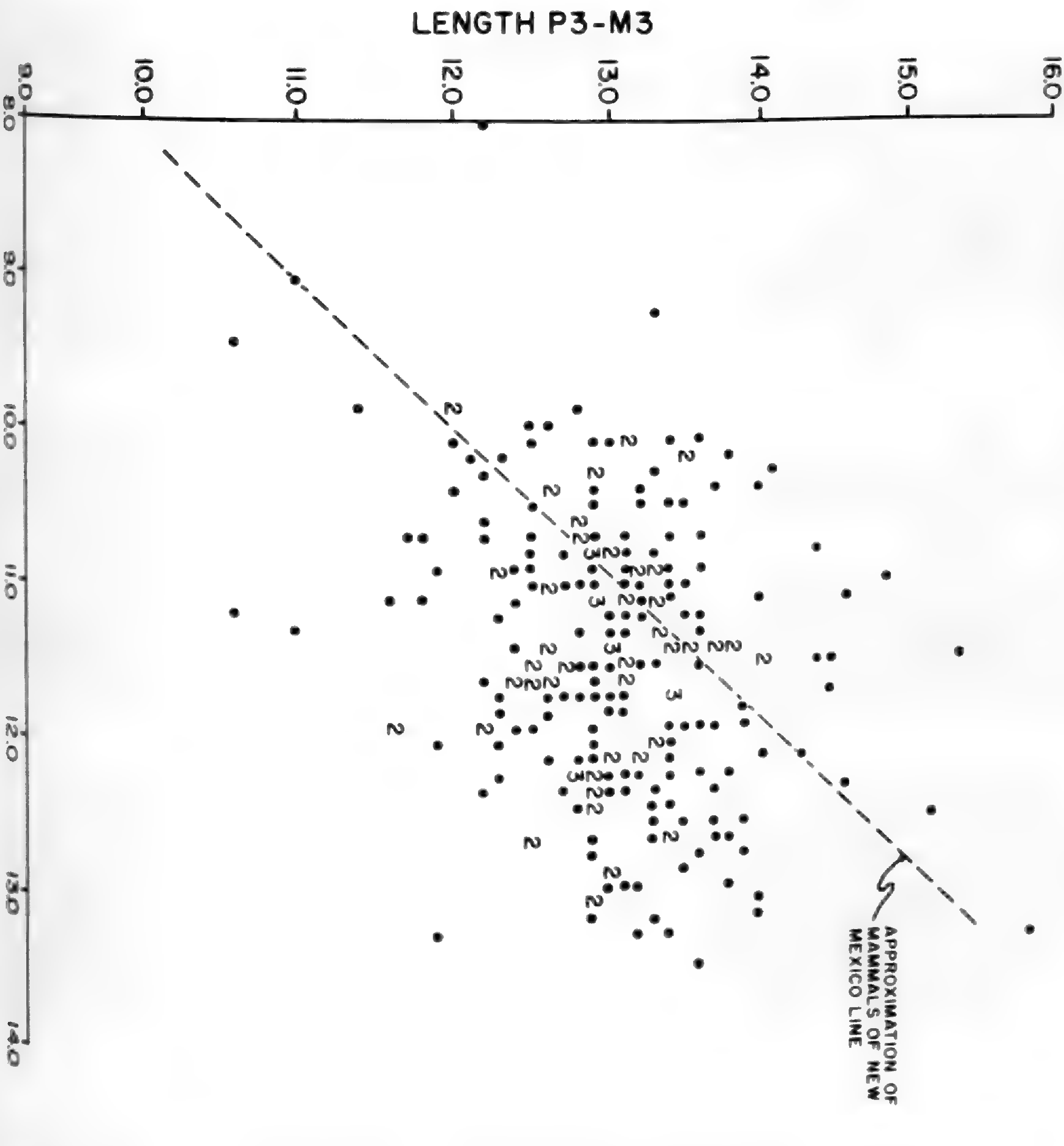


FIG. 2.–*Bivariate plot of the Dolores archaeological mandibles with the line from Findley et al. (1975:Fig. 35) superimposed. Specimens of Nuttall's cottontail are supposed to fall above the line while those of desert cottontails should fall below.*

separating desert and Nuttall's or eastern cottontail provided by Findley et al. (1975: Fig. 35) was then placed on the scattergram. Mandibles falling above the line were identified as Nuttall's cottontail while those falling below the line were identified as desert cottontail.

A second scattergram was constructed for the relationship between mandibular depth and the shorter measure of alveolar length (P_3-M_1). In this scattergram the species assignments made on the basis of the first scattergram were used to assess the probable species of the mandibles for which distance B was lacking. In those cases in which it remained unclear, the crenulation of the enamel border was used as the arbiter of probable species. However, we considered these identifications to be unreliable compared to those made obvious by the bivariate plot.

We then used the species determinations to test the expectation of localized procurement of cottontails among the Dolores Anasazi by examining distribution of species across space and through time at Dolores archaeological sites. This has been reported in Flint and Neusius (in press).

However, we remained dissatisfied with the method of species determination used. The bivariate plots established that both species were present in the Dolores area and utilized by the Anasazi. They did not indicate how reliable the species identifications were. In instances in which our subjective evaluation of crenulation of the enamel border was the primary indicator, we considered the identifications unreliable, but more subtle variation in accuracy was not obvious. Because correct identification was important to the analysis of the temporal and spatial distributions of these species, we wanted to assess our accuracy more thoroughly.

SPECIES DETERMINATIONS USING DISCRIMINANT ANALYSIS

Thus, we made a second attempt to determine species using mandibular measurements. We decided to use discriminant analysis on a group of modern cottontails whose species were known and then employ the discriminant function to classify our prehistoric unknowns. Discriminant analysis is an appropriate technique for such classification (Klecka 1980:7-8), and provides probabilities for the group assignment of each case.

The U.S. Fish and Wildlife Service in Fort Collins, Colorado provided a sample of known cottontail mandibles from their skeletal collections. Distances A and B for 41 adult individuals already had been measured, and we were able to measure distance C on the same individuals. Twenty-five of the individuals from the Fish and Wildlife Service had been identified as *Sylvilagus audubonii baileyi* at the time of capture while sixteen had been identified as *Sylvilagus nuttallii grangeri*. We also had measurements on five additional individuals from the collections at Mesa Verde National Park and Fort Lewis College which had been identified from soft tissue characteristics. One of these had been identified as *Sylvilagus audubonii warreni (Sylvilagus audubonii cedrophilus* per Hall, 1981:Map 225). One was considered *Sylvilagus nuttallii pinetis* and three were simply assigned to *Sylvilagus audubonii*. This gave us forty-six known individuals with which to work. Although this sample was not overly large, it was larger than that apparently used by Findley et al. (N=35).

Two discriminate function analyses were performed on these individuals using the program provided by the Statistical Package for the Social Sciences (Nie et al. 1975:434-467). The first of these performed a stepwise selection of three variables corresponding to the measurements for distances A, B and C. Because distance C was highly correlated with distance B, this analysis deleted distance C from consideration. Ninety-one and three tenths percent of the modern individuals were correctly classified using this function. Because those prehistoric mandibular fragments for which only distance C was measured could not be identified using this function, a second discriminant analysis was performed using only the measurements for distances A and C. Ninety-three and five tenths percent of the knowns were correctly classified using this function.[4]

Scores on the second discriminant function were then used to assign species to the 283 adult Dolores mandibles originally classified using bivariate plots. Figure 3 is a histogram displaying the distribution of cases with respect to this second discriminant function. This procedure provided us with probabilities for group membership.

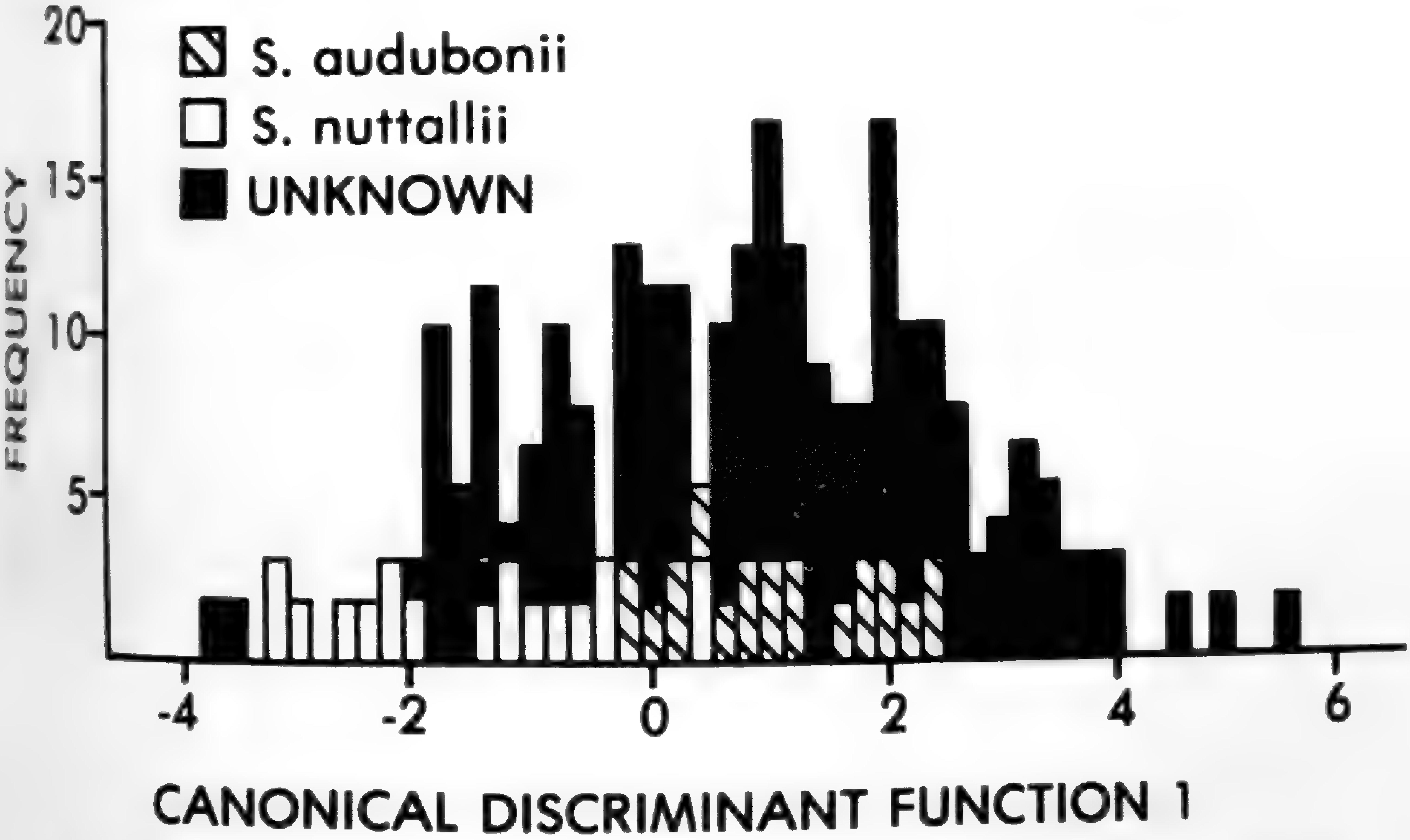


FIG. 3.–*Distribution of known and unknown mandibles along the discriminant function. Cases falling to the left of 0 were assigned to Nuttall's cottontail while those to the right were assigned to desert cottontail. Probabilities for these assignments vary according to the discriminant scores.*

DISCUSSION

The results of our work are important to zooarchaeologists. First, our analysis confirms that desert cottontails tend to have a deeper and longer mandible than Nuttall's cottontails as suggested by Findley et al. (1975), but also indicates that classification based only on this relationship is less than ideal. If we consider a probability of group membership of .90 adequate for identification, 35.8% of the prehistoric mandibles could not be identified. If a more stringent requirement of .95 is employed 45.7% cannot be identified.

Furthermore, the probabilities for those mandibles assigned to Nuttall's cottontail tend to be lower than those for mandibles assigned to desert cottontail. Over half (54.8%) of the mandibles assigned to Nuttall's cottontail have probabilities of less than .90 while this is true for only 37.6% of those assigned to desert cottontail. This may result from a smaller number of known Nuttall's cottontails or it may indicate greater variability within this species.

It is interesting that desert cottontails apparently represent such a high proportion of the prehistoric mandibles. We expected Nuttall's cottontail to predominate in the Dolores faunal assemblages both because much of the project area was forested prehistorically (Bye, in press; Petersen, in press) and because much of it was above the 7000 feet elevational limit for desert cottontail (Armstrong 1972:85). However, since our subjective observations within the project area today did not fit with this expectation, we made no attempt to weight the discriminant analysis in favor of one or the other species. Until better discrimination between these species is possible, we can only speculate that the Dolores data is important to understanding the biogeographic relationships of these species.

The discriminant analysis also results in some mandibles being assigned to a different species than was suggested by the use of bivariate plots. Thirty-nine (10.2%) of the prehistoric mandibles were assigned to a different species by the discriminant analysis. The probabilities of group membership do tend to be low for this group. Within it 74.4% of the cases are assigned to a species with probabilities of less than .90. Nevertheless, it is clear that the modern population we obtained differs from that used by Findley and his coworkers with respect to these two characters. Sample size could be a factor here, but it is also possible that subspecific variation is involved. Most of the modern desert cottontails measured by us were assigned to *S.a. baileyi*, a subspecies which does not occur in New Mexico (Hall 1981:Map 225). Similarly most of the modern Nuttall's cottontails were assigned to *S.n. grangeri* which also does not occur in New Mexico (Hall 1981: Map 223).

Finally, the use of discriminant analysis in zooarchaeological analysis may be preferable to that of bivariate plots even if such a small number of variables is involved. This is because it provides probability assessments for the species assignment of each mandible. However, the discriminant analysis also indicates that the relationships between these species is not adequately defined by these characters alone. Separation could be improved by obtaining a larger sample of known specimens, adding more characters to the analysis[5] and investigating the possibility of subspecific variation.

We intend this article as a caution to zooarchaeologists attempting to identify cottontail species. Certainly it is naive to apply the plot provided by Findley et al. to a variety of archaeological situations without further research on the variability in these characters between species. However, we do not mean to suggest that the separation of cottontails not be attempted by zooarchaeologists. A number of important behavioral and environmental questions may be addressed through detailed study of cottontail remains. We think that this is an instance in which further investigation of taxonomic and distributional relationships by zooarchaeologists is required in order to do justice to zooarchaeological data bases. We hope that this summary of our analyses serves as a stimulus to further study of this topic.

ACKNOWLEDGMENTS

We are grateful to the Dolores Archaeological Program for funding our cottontail study of which this article is an outgrowth and for letting us use figures from Flint and Neusius (in press). Dr. Robert Findley was an invaluable source of encouragement and information and provided access to the collections of the U.S. Fish and Wildlife Service in Fort Collins as well as his own measurements on modern cottontails. Alan Bohnert of Mesa Verde National Park and Dr. Phillip Duke of Fort Lewis College also provided modern cottontail specimens for measurement. Dr. Bruce Bradley started us thinking about the validity of using mandibular measurements. The Center for Archaeological Investigations, Southern Illinois University provided the environment in which the implications of our study could be assessed as well as specific production support. We particularly appreciate the comments and encouragement of Phil Neusius, Lynne Peters, Bob Leonard, Dr. Susan Ford, and Dr. Rob Corruccini. The review of J.D. Stewart and the editorial comments of the editor of this journal also have been helpful. These individuals have greatly expanded our horizons although we alone are responsible for this article.

LITERATURE CITED

AKINS, NANCY J. 1984. Prehistoric faunal utilization in Chaco Canyon: Basketmaker III through Pueblo III. Unpubl. Ms. in files of authors.

ANDERSON, ELAINE. 1980. Fauna. Pp. 123-149 *in* The Durango South sites in the Durango district (John C. Gooding, ed.). Anthrop. Pap. Univ. Arizona 34, Tucson.

ARMSTRONG, DAVID M. 1972. Dis-

LITERATURE CITED (continued)

tribution of mammals in Colorado. Mon. Mus. of Nat. Hist. Univ. Kansas 3, Lawrence.

BERTRAM, JACK B and NEALE DRAPER. 1983. The bones from the Bis a'ani Community: a sociotechnic archaeofaunal analysis. Pp. 1015-1016 *in* Bis a'ani: a late Bonito Phase community on Escavada Wash, northwestern New Mexico (Cory D. Bretemitz, David E. Doyel, and M.P. Marshall, eds.). Navajo Nation Pap. in Anthropology 14, Gallup.

BINFORD, MARTHA R., WILLIAM DOLEMAN, NEALE DRAPER and KLARA B. KELLEY. 1982. Anasazi and Navajo archaeofauna. Pp. 448-1057 *in* Anasazi & Navajo land use in the McKinley Mine area near Gallup, New Mexico (Christina G. Allen & Ben A. Nelson eds.). Office Contract Arch., Univ. New Mexico, Albuquerque.

BISSELL, STEVEN J. and MARY BETH DILLON. 1982. Colorado mammal distribution latilong study. Colorado Div. of Wildlife, Denver.

BYE, ROBERT A. JR. in press. Reconnaissance of the vegetation of the Dolores Project. *In* Dolores Archaeological Program Studies in Environmental Archaeology (Kenneth L. Petersen, Vickie L. Clay, Meridith H. Matthews and Sarah W. Neusius compilers). U.S. Dept. Int., Bur. Recl., Office Eng. and Res., Denver.

CORDELL, LINDA S. 1977. Late Anasazi farming and hunting strategies: one example of a problem in congruence. Amer. Antiqu. 42(3):449-461.

FINDLEY, JAMES S., ARTHUR H. HARRIS, DON E. WILSON, CLYDE JONES. 1975. Mammals of New Mexico. Univ. New Mexico Press, Albuquerque.

FLINT, PATRICIA ROBINS and SARAH W. NEUSIUS. In press. Cottontail rabbit procurement among Dolores Anasazi. *In* Dolores Archaeological Program Supporting Studies I:Settlement & Environment. U.S. Dept. Int., Bur. Recl., Office Eng. & Res., Denver.

HALL, E. RAYMOND. 1981. The mammals of North America. 2nd edition. John Wiley & Sons, New York.

HARRIS, ARTHUR H. 1963. Vertebrate remains & past environmental reconstruction in the Navajo Reservoir District. Mus. of New Mexico, Pap. in Anthropology II, Albuquerque.

__________. 1970. Past climate of the Navajo Reservoir District. Amer. Antiq. 35(3):374-377.

HULBERT, RICHARD C., JR. 1984. Latest Pleistocene and Holocene leporid faunas from Texas: their composition, distribution and climatic implications. The Southwestern Naturalist 29(2):197-210.

NIE, NORMAN H., C. HADLAI HULL, JEAN G. JENKINS, KARIN STEINBRENNER and DALE H. BENT. 1975. Statistical package for the Social Sciences. 2nd edition. McGraw-Hill, New York.

KLECKA, WILLIAM R. 1980. Discriminant Analysis. Sage Publications, Beverly Hills, California.

NEUSIUS, SARAH W. 1985. The Dolores Archaeological Program faunal data base: resource availability and resource mix. Unpubl. Ms. on file, Dolores Arch. Prog., Dolores.

ORR, ROBERT T. 1940. The rabbits of California. California Acad. of Sci. Occas. Pap. 19. San Francisco.

PETERSEN, KENNETH L. in press. Natural vegetation of the Dolores Project area, ca. 1920. *In* Dolores Archaeological Program Studies in Environmental Archaeology (Kenneth L. Petersen, Vickie L. Clay, Meridith H. Matthews and Sarah W. Neusius compilers). U.S. Dept. of Int., Bur. Recl., Office Eng. and Res., Denver.

PIPPIN, LONNIE C. 1979. The prehistory & paleoecology of Guadalupe Ruin, Sandoval County, New Mexico. Unpubl. PhD Dissert., (Anthropology), Washington State Univ., Pullman.

NOTES

[1]Since 1978 the Dolores Archaeological Program has been under contract with the U.S. Department of Interior, Bureau of Reclamation (Contract No. 8-07-40-S0562) to mitigate the effects of the construction of the McPhee Dam and Reservoir in Montezuma County, Colorado. Faunal remains have been recovered from approximately 150 archaeological sites the majority of which belong to the Anasazi cultural tradition and date between A.D. 600 and 950.

[2]The modern range of eastern cottontail is far removed from the Dolores area (Hall 1981: Map 223). Thus, we did not anticipate the presence of this species in the area during the period of Anasazi occupation.

[3]Crenulation of the enamel of all cheek teeth has been examined by Orr (1940) for California cottontails and may be useful for Colorado cottontails as well (R. Findley pers. communication).

[4]The authors are aware that more variables are normally used in discriminant analysis. However, Klecka (1980:15) specifically indicates that we have not violated any basic assumptions of this technique. We used this technique because it allowed us to assign group membership or species with a probability, the exact problem with the bivariate plots which we sought to remedy.

[5]Hulbert (1972) uses dental characters which might be of use.

Book Review

Jimeno Santoyo, Myriam, & Adolfo Triana Antorveza (1983) Medicina, shamanismo, y botanica (Medicine, shamanism, and botany). Bogota: Prescencia. Paper, 156 pp. $11.50.

This is an anthology containing the following articles, all in Spanish:

1. *Medicina institucional y saber indigena: conclusions de dos talleres de salud (Institutional medicine and native knowledge: conclusions of two health-care offices).* by Myriam Jimeno S.
2. *Conceptos indigenas de enfermedad y equilibrio ecologico: Los Tukanos y los Kogi de Colombia (Native concepts of disease and ecological equilibrium: the Tukanos and the Kogi of Colombia).* by Gerardo Reichel-Dolmatoff.
3. *Jaïbanas, Neles y enfermedad: Litoral Pacifico (Jaibanas, Neles, and disease: the Pacific Littoral).* by Nina S. de Friedmann.
4. *Shamanismo: Irracionalidad o coherencia (Shamanism: irrationality or coherence)?* by Miguel Lobo Guerrero & Xochilt Herrera.
5. *Cosmovision y el concepto de enfermedad entre los Ufaina (Cosmology and disease concepts among the Ufaina).* by Martin von Hildebrand.
6. *Nuestra medicina esta en la naturaleza, en la tierra (Our medicine is in nature, in the earth).* by Herbierto Oyuela.
7. *El modelo de la Medicina Institucional, posibilidades y limites (The model of institutional medicine: possibilities and limitations).* by Camilio Arbalaez.
8. *Las leyes de la Homeopatia (The laws of homeopathy).* by Miguel Riveros.
9. *El concepto de enfermedad y los principios de la Homeopathy (The concept of disease and the principles of homeopathy).* by German Palomares.
10. *Alucinogenos psicotropicos derivados de las planta (Psychotrophic hallucinogens derived from plants).* by Hernando Garcia Barriga.
11. *Un programa alternativo de salud para grupos indigenas (An alternative health-care program for indigenous peoples).* by Adolfo Triana Antorveza, & Cesar Mendez.
12. *Programa de servicios primarios de salud en Choco (Program of primary health-care services in Choco).* by Edelmira Perez.

Publications published in languages other than English often receive less attention in the English-speaking world than they deserve; such is certainly the case with this work, compiled and edited by the Colombian Community Foundation (FUNCOL). The main focus of the book is the health-care systems of Colombia, both modern and indigenous, including the interplay between these two often competing forms of treatment and recent health-care projects in rural indigenous areas. It is, therefore, of only peripheral interest to most ethnobiologists, but contains a considerable diversity of material which could be useful in a wider context.

For example, the second article, written by Gerardo Reichel-Dolmatoff of UCLA, discusses native concepts of disease among the Tukanos and Kogis including descriptions of the way herbal medicine fits into the ideological basis of the indigenous health-care system. This approach is not taken often enough in studies of medicinal ethnobotany. This viewpoint is augmented in the fifth article, by Martin von Hildebrand, which analyzes the way the

Ufaina conceptualize the different ways in wild and domestic foods contribute to the *"energia vital"*.

Of special interest is the sixth article, written by Herbierto Oyuela, who describes himself as a *curandero* or native healer in the town of Boca de Tetuan Ortega-Tolima. Oyuela discusses clearly and openly the reasons, both practical and philosophical, why the native Americans of his area continue to utilize traditional forms of herbal medicine.

The tenth article, by Hernando Garcia-Barriga of the Universidad Nacional de Colombia, discusses in a very general way the uses, preparation techniques, and chemical constituents of a large variety of hallucinogenic plants and fungi. The emphasis is on those plants utilized by native Colombians, such as *Brugmansia* (i.e. *Datura), Banisteriopsis, Anadeanthera, Tanaecium, Virola,* and *Passiflora edulis,* but the article also includes such familiar items as *Cannabis, Psilocybe,* and *Erythroxylum.*

Joseph E. Laferriere
Ecology & Evolutionary Biology
University of Arizona
Tucson, AZ 85721 USA

J. Ethnobiol. 5(1):61-75 Summer 1985

PROCESSING MAPLE SAP WITH PREHISTORIC TECHNIQUES

MARGARET B. HOLMAN
and
KATHRYN C. EGAN
The Museum
Michigan State University
East Lansing, MI 48824

ABSTRACT.–The extent to which prehistoric Indians were able to produce maple sugar has been a question since Europeans first settled in eastern North America. Therefore, experiments were performed to test the efficiency and productivity of prehistoric maple sugaring techniques. Results indicate that it was possible to make maple sugar as efficiently with these techniques as with those employed during the early Historic era. Consideration is also given to the uses of maple sugar and the seasonal context of production. It is argued that it was both efficient and worthwhile for prehistoric Indians to incorporate sugaring activities into their annual subsistence cycle.

INTRODUCTION

The extent to which prehistoric Indians of the Northeastern Woodlands practiced maple sugaring is unclear. The question is not whether the Indians knew how to make sugar, but rather if prehistoric technology could support a regularly scheduled sugaring operation on a scale comparable to that of the Historic Period. Some modern authors, such as Yarnell (1964:78), argue that the absence of metal kettles for boiling the sap was a limiting factor in sugar production. Others, however, maintain that techniques such as stone boiling and/or freezing were adequate to make prehistoric sugaring an "established custom" (Havard 1896:42-43; Fernald and Kinsey 1958:268; Nearing and Nearing 1970:24). Early historic sources are contradictory as well. Charlevoix (1966:192) who traveled through the Northeast from 1720 to 1722, believed that maple sap was always used but that sugar making was taught to the Indians by Europeans. LaHontan (1905:366), however, who traveled through North America during the late 1600's, claimed that Indians made both syrup and sugar and Latifau (1924) believed the Europeans learned sugaring from the Indians.

Sugar was made throughout the Upper Great Lakes and the Northeast by both Indians and Europeans (Kinietz 1965; Nearing and Nearing 1970). Maple products were used as seasoning (Yanovsky 1936:42), as a preservative for fruit (Kohl 1956:319), as gifts (Densmore 1974), as a summer drink (Havard 1896:42; Densmore 1974:313), and possibly as a famine food (Henry 1969:211). At least occasionally, extra sugar was sold (Finley 1857). In addition, maple sugar can be stored for periods of at least a year (Densmore 1974:313) and is easily transported in bark containers (makuks) (Hoffman 1896), thus extending its subsistence value beyond the season when it is procured. Sugaring also served a social function as the days at the sugar camps were regarded by the Indians (Ritzenthaler and Ritzenthaler 1970) and Europeans (Baird 1898) as a time of celebration and social interaction.

Archaeological evidence for prehistoric maple sugaring is ambiguous and limited, in part because bark and wood utensils used do not preserve and in part because other artifacts, such as pottery and stone tools, are easily associated with other activities. On the basis of the prehistoric record, however, at least two Late Woodland sites in Michigan have been interpreted as maple sugaring sites (Lovis 1978; Kingsley and Garland 1980).

In addition, other Lake Woodland sites in Michigan are thought to be sugaring sites on the basis of environmental characteristics plus archaeological data (Holman 1984). While several lines of evidence suggest that maple sugaring was practiced prehistorically, no studies have adequately considered whether prehistoric technology was a limiting factor in this activity.

THE PROBLEM

In this paper we address the question: Was prehistoric sugaring technology adequate to support a regularly scheduled sugaring operation? To answer this, we conducted limited controlled experiments using utensils and techniques available prehistorically. These experiments allow for a preliminary assessment of the extent to which prehistoric Indians could make maple sugar. Efficiency of various techniques is measured by comparing the results of the experiments with Historic Period production in terms of time expended, fuel used, and quantities produced. Productivity and technological efficiency are evaluated in their own right as well as relative to the economic alternatives and long term benefits of this food. Finally, consideration is given to sugaring in the prehistoric subsistence/settlement systems of the Northeastern Woodlands.

The results of this study are potentially valuable for increasing our understanding of how Eastern Woodland peoples integrated scheduling of seasonally available resources into a cohesive subsistence cycle. Maple syrup and sugar are potentially valuable foods which may have been important during periods of economic deficit, i.e., early spring, when few alternative foods were available. Demonstration of the productivity and efficiency of this activity, given prehistoric technological capabilities, may thus lend support to arguments favoring prehistoric sugaring.

BACKGROUND

Maple sap is basically a solution of sugar (mostly sucrose) plus small amounts of proteins, lime, and potash in water. The sucrose in the sap is manufactured by the tree for its own growth and nutrition (Nearing and Nearing 1970:123). Part of the sucrose is used immediately for growth and part is stored for later conversion into energy. The water in sap is the vehicle which carries the food and nutrients through the tree.

Maple sap does not run when trees are in leaf (Nearing and Nearing 1970:121). The leaves are active in manufacturing the foods that are stored and used. Hence, the water, carrying nutrients from the roots is vaporized by the leaves while the nutrients are used and stored. For this reason, the water content is lowest during the growing season. Rather, sap is present in the late fall, winter and early spring when the trees are leafless. During the fall and winter, the sugar content of the sap is low because much of it has been used during the growing season and the rest is being stored in the wood and bark for later use. In the spring, however, the reserve sucrose is needed for the coming growth period and is carried up the tree through the cambium to the buds. In addition, because no evaporation has taken place since the leaves fell, water is present in maximum quantities.

In the early spring when the sap occurs in greatest quantities and the sugar content is highest, maple syrup and sugar are made (Nearing and Nearing 1970:121). During this time, sap flow is significantly influenced by the weather: it is abundant after severe freezing, but cannot run when the temperature drops below about 32°F (0°C) or rises above 50°F (10°). Thus the alternation of cold nights and warmer days in early spring constitutes sugaring weather.

Maple sugar production requires removal of 94% to 98% of the water in sap, while only 34% to 35% of the water must be removed when making syrup (Crockett 1915). During earlier historic times, this was accomplished by boiling the sap in a graduated series of metal kettles and thus evaporating the water (Densmore 1974). Now special evaporators are used. In all cases, however, the amount of water removed determines whether the product is syrup or sugar.

The collecting and processing of maple sap was a group activity as is reflected in the descriptions of Indian sugaring. Individual nuclear (Rogers 1974) or extended families (Henry 1969) conducted their sugaring in the same sugar bush each year. The sugar bush was a place set aside for this activity alone. Families lived there for the duration of the season and stored equipment there for reuse the following year (Densmore 1974). Evidence suggests that these camps were located from one-half mile (.8 km) to six miles (9.6 km) from villages where planting and fishing took place in the warm season (Holman 1984).

Often two or three families gathered at the same sugar bush (Henry 1969). Thus, the season functioned as a social occasion as well as a working one. It provided a welcome opportunity for socializing after the winter when Indian families dispersed to find game (Henry 1969; Landes 1971). Information relevant to later subsistence and social activities was also exchanged during the sugaring time.

Historic accounts indicate that all family members were involved in sugaring. Women directed the work and performed tasks requiring special skills, such as tapping the trees (Henry 1969:142; Rogers 1974:33-41). Men cut wood for the fires and children helped by tending the boiling sap. Group participation was important because collecting and boiling sap is labor intensive with several tasks to be performed at once. Nonetheless, since sap does not run every day in the season, men and boys were able to spend some time hunting and fishing as well (Henry 1969:142).

METHODS

Ethnohistorical documentation of techniques. – References to sugar making using prehistoric methods and utensils are either sketchy, inferential, or late descriptions under circumstances when metal cauldrons were not available. The statement of a Kickapoo chief is, however, often cited (e.g., Henshaw 1890; Nearing and Nearing 1970) as a direct account favoring prehistoric sugaring. He said:

> Can it be that thou art so simple as to ask me such a question, seeing that the Master of Life imparted to us an instinct which enabled us to substitute stone hatchets and knives for those made of steel by the whites; wherefore should we know as well as they how to manufacture sugar? He has made us all, that we should enjoy life; he has placed before us all the requisites for the support of existence, food, water, fire, trees, etc. Wherefore then should he have withheld from us the art of excavating trees in order to make troughs of them, of placing the sap in these, of heating the stones and throwing them into the sap so as to cause it to boil, and by this means reducing it to sugar? (Keating 1825).

Stone boiling as described by the Kickapoo chief is commonly inferred to have been the method used prehistorically because pottery or wood containers are considered unable to withstand direct heat (e.g., Nearing and Nearing 1970). Other sources, however, do state that direct boiling over the fire was possible so long as pottery was covered by wet clay or birch bark vessels placed only over coals (H. Smith 1933:93; Nearing and Nearing 1970:20).

Freezing is also frequently cited as a method employed by the Indians to reduce the water content of the sap to produce syrup (Havard 1896; H. Smith 1933; Fernald and Kinsey 1958). Freezing of the sap in shallow containers allows the thicker sugar concentrated sap to settle to the bottom while a layer of ice, which can be easily removed, forms on the top.

From these and other references it seems that sap can be processed in vessels made of pottery (H. Smith 1933; Nearing and Nearing 1970; Densmore 1974, 1979), birch bark (Armstrong 1892; Havard 1896) or wood (Keating 1825; Havard 1896) and that evaporation is accomplished by stone boiling (Keating 1825; Havard 1896; Fernald and Kinsey 1958), direct fire (H. Smith 1933) or freezing (J. Smith 1831; Havard 1896; Fernald and Kinsey 1958). Additionally, a combination of vessel types and/or techniques may be used.

Techniques and devices for collecting sap are not at issue in the controversy surrounding prehistoric maple sugaring. The amount of sap collected and the means for doing so remained the same until the recent advent of plastic tubing in some operations (e.g., Nyland 1966). Likewise, bark collecting vessels and wooden troughs were used by some people into the present century (Rogers 1974; Densmore 1979). Rather, as noted, the problem centers on the adequacy of prehistoric technology for evaporating the water from the sap. Thus, this study focuses on the actual processing of sap into syrup and sugar.

THE EXPERIMENT

Since the collection of sap is time consuming and not critical to solving the problem of prehistoric sugaring, sap was purchased on March 22, 1984 from a local sugaring operation. Because our time was limited to one day, the quantity of sap obtained was 40 gallons (151.4 l). This amount, when processed, was projected to yield about one gallon (3.8 l) of syrup or six to eight pounds (2.72 or 3.63 kg, respectively) of sugar (Thompson 1978). While this is nowhere near the amount processed in a normal season, it was considered sufficient to experiment with the various techniques discussed above and to obtain data on the length of time needed to manufacture the final product. This is turn can be compared to other time/efficiency data where historic methods were used.

Freezing, stone boiling and direct fire, the three historically and ethnobotanically referenced techniques, were tested. Each technique was tested independently and in concert with the other techniques. In addition, records were kept of each step of the sugaring process. Quantities boiled, time expended, fuel used and process employed were all noted.

Freezing was a technique used historically for initially removing some of the water from the sap so that less boiling was necessary (J. Smith 1831). Freezing may also have been used prehistorically to produce sugar. Smith (1831) states that the sap was intentionally frozen and the ice cast off several times in an instance when the Indians he was living with made sugar without kettles (see also Havard 1896).

For purposes of our experiment, we took one-half of the original sap, having a sugar content of 3%, and allowed it to freeze overnight. Half of this quantity was set out on an open porch while the other ten gallons (37.9 l) were set on a semi-enclosed porch. Ice formed and was cast off the sap on the open porch three times thus reducing it from 10 gallons to five (18.9 l) and increasing its sugar content from 3% to 6%. Ice formed on the sap set on the enclosed porch only once and consequently only reduced its volumn by 1.5 gallons (5.7 l) while increasing the sugar content to approximately 3.5% (Fig. 1).

The second stage of our experiment involved boiling down the sap. Various types of containers were possibly used in prehistoric sugaring. Ceramic and birch bark vessels are most frequently mentioned in the literature. Consequently, to assess the advantages and disadvantages of each kind of vessel, half of the sap used in stone boiling was placed in birch bark containers and half in ceramic pots (Fig. 2). Only birch bark vessels, however, were used directly over the coals because the ceramic vessels used in the experiment were deemed unsuitable for direct heat.

The ceramic pots used were unglazed, straight sided vessels with flat bases and a capacity of two quarts (1.9 l). Rim diameters were 20 cm and 21.5 cm and vessel heights were 16.5 cm and 17.2 cm. The pots differed from most prehistoric vessels in the Upper Great Lakes in the bases which prehistorically were rounded or semiconoidal (e.g., McPherron 1967). They were similar to prehistoric counterparts in that they were fired at low temperatures and were comparable in size.

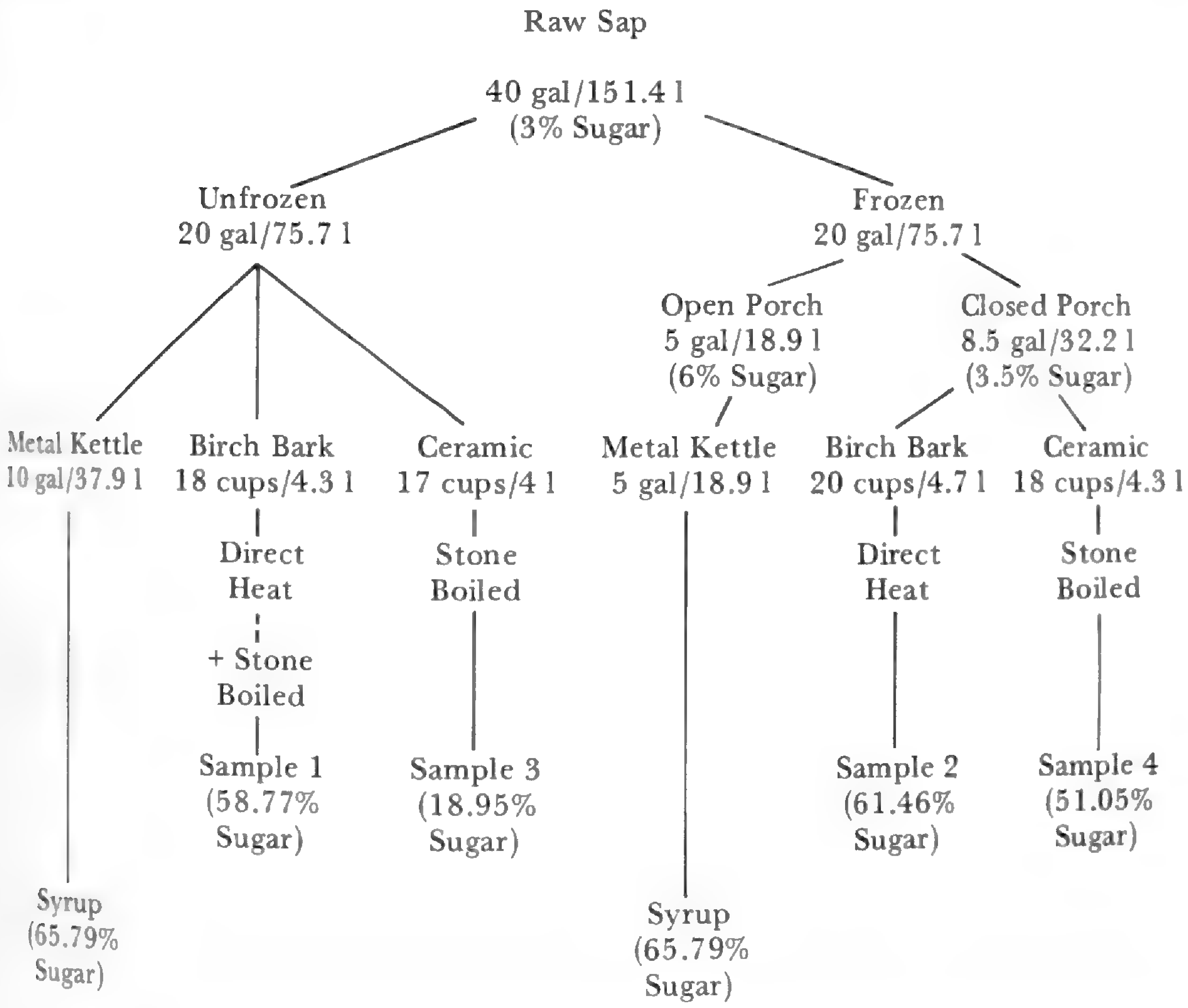


FIG. 1.–Techniques Used in Sap Processing Experiment.

FIG. 2.–Bark and Ceramic Vessels Used in Experiments.

Three of the birch bark vessels, like the pots, had a two quart (1.9 l) capacity. They were tray shaped, however, with a depth of 9 cm, widths from 13 to 25 cm and lengths of 28 to 35 cm. The trays were shallow so that a large area of liquid surface was exposed to heat from the coals underneath the vessels. A fourth bark container was like a kettle, pyramidal in shape, with a flat base and a capacity of about three gallons (11.4 l).

Unfortunately, we were not able to process as much sap as we originally intended. This is primarily because we did not have enough large containers to process the sap. As it turned out, our experiments helped to demonstrate something implied in the ethnographic literature (Densmore 1974); that is, when birch bark comes directly in contact with flames, it will ignite. Consequently, we lost the three gallon (11.4 l) vessel early on in the experiment and thus reduced our processing efficiency.

The small volumes which we were able to process provided illuminating results. Comparable volumes of sap, both frozen and unfrozen, were processed using each of the prehistoric techniques in various combinations. It should be noted that the birch bark vessel samples, with the greater sugar concentration, were in fact processed for lesser periods of time. It is also of interest that the samples we processed for five hours in metal kettles on electric stoves, done for purposes of comparison, were boiled for only 14% less time than the longest time for processing sap using prehistoric techniques. It also reduced by approximately the same volumetric ratio. This suggests that there is not a significant increase in the efficiency of metal kettles over prehistoric type vessels.

Content analysis provides additional insight into our results. Three samples of the sap boiled using prehistoric techniques were analyzed for sugar and ash content by the Laboratory Division of the Michigan Department of Agriculture (Table 1). These included yields from unfrozen sap boiled over the coals in birch bark for 5 hours and 15 minutes (Sample 1), frozen sap boiled directly over the coals in birch bark for 6 hours and 15 minutes with stone boiling being added for the last one hour and 45 minutes of the process (Sample 2), and unfrozen sap boiled in a ceramic vessel for 6 hours and 25

TABLE 1.–Content Analysis of Processed Sap.

	Sample 1 (5 hr., 15 min.)	Sample 2 (6 hr., 15 min.)	Sample 3 (6 hr., 25 min.)	Sample 4* (6 hr., 25 min.)	Michigan Average**
Liquid	39.4	35.91	78.5	33.31	33.8
Total Solids	60.6	64.1	21.5	51.23	66.2
Sugars	58.77	61.46	18.96	49.68	65.79
Sucrose	56.78	59.22	18.49	48.0	62.95
Fructose	0.60	0.77	0.13	0.49	1.12
Glucose	1.39	1.47	0.34	1.18	1.72
Total Ash	0.8	0.87	0.60	0.68	0.59
Other Solids	0.9	1.81	1.94	1.85	0.0

Total solids determined by Abbe' Refractometer. Solids diluted with Acetonitrile and sugars subsequently determined by High Pressure Liquid Chromatography. All results except total solids were calculated on a dry basis.

*Estimated

**Composition meets U.S.D.A. criteria.

minutes (Sample 3). The fourth sample of frozen sap, stone boiled in a ceramic vessel for 6 hours and 25 minutes, was analyzed for sugar content only and the other components were estimated on the basis of the sugar content. In addition to the results of these analyses, as shown in Table 1, the Michigan average for maple sugar is provided as a point of comparison. The Michigan standards are significant because they identify the point at which boiled sap will not ferment and therefore be considered syrup. Achieving a non-fermentable syrup is therefore important for long term storage.

Sugars are not the only component considered. Interestingly, based on Michigan and U.S.D.A. standards, the critical test has been not for sugar content, but rather for ash content (Jones 1928:25). Ash contributes to the flavor of maple syrup. Therefore, unlike syrups made from most other sugars, maple syrup is never subjected to chemical or other forms of clarification because removal of the ash would destroy the flavor.

Although ash must be present in authentic maple syrup, the bulk of the total solids in syrup is, of course, sugar. In recent years, the total solid content of maple syrup is required to be at least 66% (U.S.D.A. 1977), although in the past the standard in both the U.S.A. and Canada was 65%. Syrup having 65% or 66% totals solids will thus have 35% or 34% total liquid. Variation around these percentages is fairly small because syrup that is too thin will ferment and syrup that is too thick will granulate (Snell 1913:36).

In considering the results as displayed in Table 1, it is clear that the sap stone boiled in ceramic pots (Samples 3 and 4) at 21.5% and 51.2% total solids is a long way from being identified as maple syrup. This is despite the fact that stone boiling was continuous for 6 hours and 25 minutes. Sap processed in birch bark trays, however, is very close to syrup at 60.6% (Sample 1) and 64.1% (Sample 2) total solids. It is interesting that Sample 2, which is the closest to syrup, is the sample where a combination of techniques was used. That is, the container was placed directly over coals for the entire processing time of 6.25 hours and was also stone boiled for the last 1.75 hours. There is no doubt that had samples 1 and 2 been processed a little longer, the previous maple syrup standard of 65% total solids, or the recent standard of 66% total solids, would have been achieved.

There is likewise no doubt that U.S.D.A. standards of quality would not have been achieved. As can be seen in Table 1, all samples have a portion of total solids consisting of material that is neither sugar nor ash. Foreign matter is highest in the samples where stone boiling was used because soot from the fire, adhering to the stones, was added to the boiling sap along with the stones. U.S. Grade A table syrup must be "practically free of foreign material such as pieces of bark, soot, dust and dirt" (U.S.D.A. 1977). The problem of additional soot and ash might be remedied by incorporating a water bath into the stone boiling process. Ethnographic references (e.g., Wilson and Towne 1978:389), noted after our experiments were performed, indicate that often times stones from the fire were briefly dipped in water to remove the soot. Use of this procedure would likely have improved the flavor and quality of the syrup we produced.

Efficiency.–It is possible to make maple syrup using prehistoric technology. An important question remaining, however, is whether sugaring is worth the time, labor, and amount of fuel that must be expended.

It is evident that stone boiling sap in a ceramic pot is not at all efficient (Table 1). After 6 hours and 25 minutes, the sap in the ceramic vessels was only 18.5% and 48.0% sugar. This is far from the average of 65% in real maple syrup. By comparison, the sap processed in birch bark trays came very close to the syrup in 5.33 hours, and 6.25 hours.

The process of rotating hot stones from the fire to the vessels is, of course, tedious but it is not difficult in the sense of using a great deal of energy. Given enough workers and a routine, it would be possible to do. However, an expenditure of at least twice as much time and fuel would be required. Since a rolling boil can be maintained with hot stones, it is probably not the activity of stone boiling but rather the shape of the ceramic pots which prevented the sap from reaching a syrup state in the time expended. The birch bark trays, on the other hand, exposed more surface to the heat than did the pots and thus evaporation took place at a faster rate.

In order to compare the rate that syrup can be achieved using prehistoric methods to the rate using metal kettles, some of our sap was boiled on the kitchen stove. Five gallons (18.9 l) of sap were cooked into syrup in a period of five hours. Therefore, in terms of processing time, kettles were only about 1/6 more efficient than birch bark.

The modern evaporator converts sap into syrup in about an hour. This represents an increase in the rate of evaporation of kettles that is similar in scale to the increase seen in birch bark trays over ceramic pots. The reason for both "quantum" leaps in processing time are likewise similar. The evaporating machines used today, like the birch bark trays, are shallow and there is thus greater area for exposure to heat and evaporation.

Fuel.–It can be seen that the time required to process sap in birch bark trays is not much longer than that necessary to boil sap in metal kettles. Likewise, fuel expenditure is not much greater. It is expected that a "backyard" sugaring operation will require about one cord of wood to boil 40 gal. (151.4 l) of sap into one gallon (3.8 l) of syrup (Thompson 1978). This experiment used 1/5 cord of wood to boil 8.3 gallons (31.4 l) of sap, which is reasonably close to 1/4 cord for 10 gallons (37.9 l) of sap required when using metal cauldrons.

It has been noted (Richard Ford, pers. comm. 1984) that "cutting" enough wood for maple sugaring, prior to the introduction of metal axes, might have been the limiting factor in prehistoric sugaring. While some cutting may have been necessary, quality firewood (hardwoods) would also be available on the forest floor as a byproduct of the natural self-pruning that occurs in mature forests (cf. beech-maple forest). Therefore, fuel is not considered a limiting factor significant enough to preclude prehistoric maple sugaring.

CONCLUSIONS

It is clear from the results of our limited experiments that it is possible to make maple syrup with containers made of materials available to Native Americans. Further, syrup making can take place with almost the same amounts of labor and time using "native" technology and pre-nineteenth century techniques. Given more time, there is little doubt that sugar, as well as syrup, could have been made.

It is instructive that the most efficient results were achieved using flat, birch bark trays because this is comparable to improvements made in modern maple syrup equipment, i.e., evaporators. Thus it must be recognized that using a metal kettle is not a necessary condition for maple sugaring. As the Nearings point out metal cauldrons also have shortcomings:

> The method of boiling in cauldron kettles was an endless affair and wasteful of time, labor and fuel, while quality and color necessarily suffered. It was difficult to take the finished syrup out of the unwieldly kettles unless the fire was low and plenty of help was around. So the tendency was to add more and more sap and boil the resulting syrup over and over again all day (1970:54).

The later use of a graduated series of kettles such as those described by Densmore (1974:309) necessarily represented some improvement in efficiency by preventing the problem of reboiling the same syrup over and over. The greatest increase in sugaring efficiency, however, was first the use of flat bottomed pans and then the evaporator which was invented in 1866 (Nearing and Nearing 1970:56). Both the pans and the evaporator are flat and shallow. Thus, more of the surface of the boiling liquid is exposed to heat and evaporation so that both time and fuel are saved.

In summary, increasing the amount of surface exposed to heat seems to be extremely important regardless of the material of the container used. It is likely then that prehistoric sugaring was not done in ceramic pots because of their low efficiency. Rather, the sap was processed in large birch bark pans or perhaps in wooden troughs as suggested by the Kickapoo chief cited above.

The practice of freezing the sap, like the use of flat, shallow containers saves time, energy and fuel in syrup making. This is reflected in the disparate sugar contents of the frozen and unfrozen sap boiled in ceramic pots. Although freezing does increase efficiency, it is a technique that could not always be controlled because it is dependent upon the weather. Thus freezing may have been used when possible but was not reliable on a day to day basis.

Given that prehistoric Indians could make maple syrup and/or sugar with an efficiency comparable to that of the early European settlers, the question becomes whether it was worth doing so. The task under any circumstances is not only labor intensive but requires moving to a specific location and focusing the energies of several people in the process. The question then must relate to the context of the yearly cycle as practiced by particular people in particular places. Hence, the advantages of sugaring need to be weighed against the use and scheduling of other resources.

In northern climes, such as the Upper Great Lakes, New England and eastern Canada, the availability of other foods is low in the early spring. This is true for both hunter-gatherers and farmers. Animals are lean after the long winter, fish have yet to begin spawning, migrating birds have not returned north, and most plants are not yet productive. Further, hunter mobility is greatly reduced in the early spring (LaHontan 1905). The relative absence of other foods and the difficulty of obtaining them creates a situation where the entire labor force of an extended family is available for the sugaring period of four to six weeks. Because productivity during the sugar season is variable, however, supplementary hunting and fishing can and did take place (e.g., Henry 1969). Farmers, like hunter-gatherers, have fewer activities to occupy their time during the early spring. Tilling the soil and planting are yet to begin. Again, the entire family can devote its labor force to sugaring. Thus the timing and duration of the sugaring season *vis a vis* other resources and the availability of labor are relevant factors in choosing to make sugaring a regular part of the seasonal cycle.

The presence of an extended family of men, women and children at the sugar camp, coupled with the fact that other families can process sap nearby, offers an important social opportunity as well. Information so necessary to hunter-gatherers can be exchanged and decisions about the coming warm season can be made. Further, the possibility of simply socializing after the isolation of winter must be considered. Virtually every ethnographic description of sugaring emphasizes the holiday atmosphere of the sugar camp. While the social aspects cannot be quantified, they likewise cannot be neglected as an important benefit in the early spring.

Another consideration is whether the products of boiled maple sap are useful enough to make their manufacture worthwhile. Maple sugar can be stored for long term use, is easily carried, can function as a preservative, provides essential nutrients, was considered a remedy, and is flavorful. Densmore (1974) notes that maple sugar can be stored for at least a year. Thus it is available over the course of the entire seasonal cycle. Additionally, it is easy to carry in small birch bark makuks (Hoffman 1896:288) or small cakes (JCB 1941:94), when traveling.

Maple sugar can also be used as a preservative. Thus, Kohl (1956:319) notes that fruit was preserved with it. This was, potentially, a valuable use since many ethnographic and archaeological sources suggest a considerable percentage of the northern aboriginal diet was composed of fruit, fresh as well as dried/"preserved" (Yarnell 1964; N. Cleland 1977).

The properties of long term storage of sugar and preservation of foods are interesting when coupled with the fact that maple products constitute good sources of carbohydrate and calcium, as well as other nutrients (Black 1980; Leaf 1963). Syrup may contain 40 to 80 mg of calcium, 3 to 6 mg of phosphorous, 10 to 30 mg of potassium, and 4 to 25 mg of magnesium per fluid ounce (30 ml), (Leaf 1963:963). Beverley Smith who is conducting intensive studies of Ojibiwa nutrition, notes that the high meat diet of traditional northern peoples required both carbohydrate and calcium from non-meat foods (1984:9).

Maple syrup and sugar may have been sources of both nutrients, since maple sugar is high in carbohydrates (90 gm), (Watt and Merrill 1975:61) and maple syrup contains comparable amounts of calcium to that found in equal volumes of whole milk (Leaf 1963:964). The storable character of maple products and the desire, among historic Indians, to store maple syrup and sugar for later consumption would thus extend the nutritional benefits of these products beyond the sugaring season (Densmore 1974; Black 1980).

Finally, maple syrup and sugar were used as seasoning (Havard 1896:42; Yanovsky 1936:42; Densmore 1974:313). Indeed, several references note that sugar was preferred over salt (H. Smith 1932:61, 1932:395, 1933:92; Kohl 1956:319; Swigart, pers. comm. 1984). In addition, vinegar was made from maple sap and mixed with sugar to make a sweet and sour meat dish (H. Smith 1932:395). Other uses include sugar being added to water to make a summer drink and to medicines to make them palatable (Densmore 1974:313).

Though syrup produced in our experiements was not U.S. Grade A in flavor, neither was the syrup produced in early historic times. Scorching, caused by sap foaming on the sides of the metal kettles, was a common occurence that imparted a bitter taste (Nearing and Nearing 1970:55). Also, because boiling was often done in the open and other foods cooked in the sap, foreign materials were often incorporated into the sap (Turner 1891). Though the matter of flavor represents a cultural preference, in view of the multiple uses of maple products and the fact that metal kettles did not necessarily produce a more flavorful product, it is possible that taste as much as any other factor was an impetus for regular prehistoric sugar making (cf. Jochim 1981).

These experiments have shown that the introduction of metal kettles was not a necessary condition for the prehistoric production of maple syrup or sugar. The labor and time required is greater using prehistoric containers, but not to an extent which would preclude prehistoric sugaring. Likewise, there was no differentce in the seasonal context of sugaring nor the varied benefits conferred by the product. It is likely then that sugaring was as regularly practiced in many places prehistorically as it was historically.

It is noteworthy that these experiments, which were based on descriptions in documentary sources, are supportive of the reliability of ethnohistoric accounts of sugaring. The apparent ambiguity of the written record reflects the range of available kinds of containers that can be used to process sap. It is possible too that contradictory opinions as to the ability of prehistoric Indians to make syrup or sugar are based on accurate observations. Some early writers may not have seen a complete or normal seasonal cycle. For example, an individual may not have been present for an entire year or social disruption, such as that experienced by the Huron in the 1600s, may have precluded sugaring. It may be too that early travellers accompanied male hunters and/or warriors rather than whole families or villages. Thus, they might not have seen sap processed. Economic context and group composition are both important factors in sugaring. Both are valuable and both need to be taken into account when evaluating ethnohistoric sources on this topic.

Finally, the problem of identifying prehistoric sugaring sites remains. It is our contention that their presence must in part be determined on the basis of the subsistence/settlement system of a given population. In addition, there are ecologic and topographic attributes distinctive of maple sugaring camps (Holman 1984). Though previous research (Holman 1984) suggested that large numbers of ceramic vessels might also be characteristic of sugaring sites this is now being reconsidered in light of our experiments. Instead, we must look for anomalous patterns in site assemblages which cannot be accounted for by more traditional explanations.

ACKNOWLEDGEMENTS

Facilities of The Museum, Michigan State University, were made available for this project by C. Kurt Dewhurst, Director. Val Berryman and Terry Shaffer of The Museum plus Rick Zurel supplied birch bark for the kettles and trays used in the experiments. Linda Kalanitch made the clay vessels used and in addition donated others. Richard J. Seltin, former chair of the Department of Natural Science, Michigan State University, gave us basalt samples for stone boiling. Mr. Fontz of the Michigan Department of Agriculture and Ms. Renate Dezacks of Plant Biology Research at Michigan State University analyzed processed sap. Al Hafner of the Michigan Bureau of Standards supplied us with copies of the U.S.D.A. standards for maple syrup. Maple sap was purchased from George Fogel of Sugar Bush Supply in Mason, Michigan. Computer time was provided by Fran King of the Illinois State Museum and the Whittiers of East Lansing.

Practical advice and encouragement were generously offered by Jerry Wilson, Beth Andrus, Rick Zurel, Michael Hambacher, James Robertson, Philip Franz, Beverley Smith, Shela McFarlin, Donald Weir, Charles Cleland and William Lovis. In addition, discussions with Susan R. Martin and Richard I. Ford were most helpful. Finally, the finished manuscript was read and commented on by James McClurkin. Clearly maple sugaring remains a cooperative enterprise and to each of these people we extend our thanks.

LITERATURE CITED

ARMSTRONG, BENJAMIN G. 1892. Early life among the Indian, reminiscences from the life of Benjamin G. Armstrong. Dictated to and written by Thos. P. Wentworth. Press of A.W. Browion, Ashland, Wisconsin.

BAIRD, ELIZABETH THERESE. 1898. Reminiscences of early days on Mackinac Island. Coll. of the State Hist. Soc. of Wisconsin 14:29-34.

BLACK, MEREDITH JEAN. 1980. Algonquin ethnobotany: an interpretation of aboriginal adaptation in southwestern Quebec. Nat. Mus. of Man, Mercury Series, Canadian Ethnol. Service Paper No. 65.

CHARLEVOIX, PIERRE DE. 1966. Journal of a voyage to North America. Univ. Microfilms Inc., Ann Arbor. Originally published 1761, printed for R. and J. Dodsley, London.

CLELAND, NANCY N. 1977. Identification of plant remains from prehistoric sites in northern lower Michigan. Unpubl. ms. on file, The Museum, Michigan State Univ., East Lansing.

CROCKETT, WALTER H. 1915. How Vermont maple sugar is made. Dept. of Agric., State of Vermont.

DENSMORE, FRANCES. 1974. How Indians use wild plants for food, medicine and crafts. Dover Publ., New York.

———. 1979. Chippewa Customs. Repr. Ed. Minnesota Hist. Soc. Press, St. Paul. Originally publ. 1929, Smithsonian Inst. Bull. 86, B.A.E.

FERNALD, MERRITT LYNDON and ALFRED CHARLES KINSEY. 1958. Edible wild plants of eastern North America. Harper and Row Publ., New York.

FINLEY, REV. JAMES B. 1857. Life among the Indians; or personal reminiscences and historical incidents, edited by Rev. D.W. Clark, D.D. Hitchcock and Walden, Cincinnati.

HAVARD, V. 1896. Drink plants of the North American Indians. Bull. Torrey Bot. Club 23:33-96.

HENRY, ALEXANDER. 1969. Alexander Henry, travels and adventures in Canada and Indian territories between the years 1760 and 1776, edited by James Bain. M.G. Hurtig, Edmonton, Ontario. Originally publ. 1809.

HENSHAW, H.W. 1890. The Indian origin of maple sugar. Am. Anth. October III:341-351.

HOFFMAN, W.J. 1896. The Menomini Indians. 14th Ann. Rpt. of the B.A.E.

HOLMAN, MARGARET B. 1984. The identification of Late Woodland maple sugaring sites in the Upper Great Lakes. Midcont. J. of Arch. 9(1):63-89.

J.C.B. 1941. Travels in New France, edited by Sylvester K. Stevens, Donald H. Kent, and Emma Woods. Pennsylvania Hist. Comm. Harrisburg. Originally publ. 1887.

LITERATURE CITED (continued)

JOCHIM, MICHAEL. 1981. Strategies for survival. Acad. Press, New York.

JONES, C.H. 1908. The national pure food law and the Vermont maple sugaring industry, pp. 20-27.

KEATING, WILLIAM H. 1825. An Expedition to the source of St. Peter's River. Whittaker, London.

KINGSLEY, ROBERT G. and ELIZABETH B. GARLAND. 1980. The DeBoer site: a late Allegan phase site in Allegan County, Michigan. The Michigan Arch. 26(1):3-44.

KINIETZ, VERNON W. 1965. The Indians of the western Great Lakes 1615-1760 Univ. Michigan Press, Ann Arbor.

KOHL, J.G. 1956. Katchi-Gami wanderings around Lake Superior. Ross & Haines, Inc., Minneapolis. Originally publ. 1860, Chapman and Hall, London.

LaHONTAN, BARON DE. 1905. New voyages of North America, edited by R.G. Thwaites. Repr. from Englis ed., 1703. A.C. McClurg & Co., Chicago.

LANDES, RUTH. 1971. Ojibwa woman. Norton Lib., New York.

LATIFAU, JOSEPH FRANCES. 1724. Publ. of the Champlain Soc. XLIX, Toronto.

LEAF, ALBERT L. 1964. Pure maple syrup: nutritive value. Sci. 143:963-964.

LEAF, ALBERT L. and KENNETH G. WATTERSTON. 1964. Chemical analysis of sugar maple sap and foliage as related to sap and sugar yields. Food Sci. 288-292.

LOVIS, WILLIAM A. 1978. A numerical taxonomic analysis of changing Woodland site location on an interior lake chain. Michigan Acad. XI(1):39-48.

McPHERRON, ALAN. 1967. The Juntunen site and the Late Woodland prehistory of the Upper Great Lakes area. Mus. of Anth., Univ. of Michigan, Anth. Papers No. 30., Ann Arbor.

NEARING, HELEN and SCOTT NEARING. 1970. The maple sugar book. Schocken Books, New York.

NYLAND, ROGER DANIEL. 1966. Sugar maple and its use for sap production in Michigan's lower peninsula. Unpubl. Ph.D. dissert. Michigan State Univ., East Lansing.

RITZENTHALER, ROBERT E. and PATRICIA R. RITZENTHALER. 1970. The Woodland Indians of the western Great Lakes. Nat. Hist. Press, Garden City.

ROGERS, JOHN (Chief Snow Cloud). 1974. Red world and white. Univ. Oklahoma Press, Norman. Originally publ. as A Chippewa speaks.

SMITH, BEVERLEY A. 1984. Sources of vitamins and minerals in the high-protein diet of the traditional Ojibwa. Ms. in possession of author.

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

____________. 1932. Ethnobotany of the Ojibwe Indians. Bull. of the Public Mus. of Milwaukee (4(3):327-525.

____________. 1933. Ethnobotany of the forest Potawatomi Indians. Bull. of the Public Mus. of Milwaukee 7(1):1-230.

SMITH, JAMES. 1831. An account of remarkable occurences during captivity with the Indians 1755-59. Grigg, Philadelphia.

SNELL, J. F. 1913. Maple sap, its products and their limitations. Report of the proceedings of the Pure Maple Sugar and Syrup Co-operative Ag. Ass. 1:34-431. Canada.

THOMPSON, BRUCE. 1978. Syrup trees. Walnut Press, Fountain Hills, Arizona.

TURNER, JESSE. 1891. Reminiscences of Kalamazoo. Michigan Pioneer and Hist. Coll. Vol. 18, Lansing: Robert Smith and Co. State Printers and Binders.

U.S.D.A.–Food Safety and Quality Service. 1977. U.S. standards for grades of table maple syrup.

WATT, BERNICE K. and ANNABEL L. MERRILL. 1975. Handbook of the nutritional contents of foods. Dover Publ., Inc., New York.

LITERATURE CITED (continued)

WILSON, NORMAL L. and ARLEAN H. TOWNE. 1978. Nisenans. Handb. of N. Am. Ind., Vol. 8, California, edited by Robert F. Heizer, pp. 387-397. Smithsonian Inst., Washington.

YANOVSKY, ELIAS. 1936. Food plants of the North American Indians. U.S.D.A. Misc. Publ. No. 237, Washington.

YARNELL, RICHARD ASA. 1964. Aboriginal relationships between culture and plant life in the Upper Great Lakes region. Mus. of Anth., Univ. Michigan, Anth. Papers No. 23.

Book Review

Hames, Raymond B., and William T. Vickers (1983). Adaptive responses of native Amazonians. New York: Academic Press. Cloth, 518 pp.

This is an anthology containing the following articles:

1. *Introduction*, by Raymond B. Hames and William T. Vickers.
2. *Machiguenga gardens*, by Allen Johnson.
3. *The cultivation of manioc among the Kuikuru of the Upper Xingu*, by Robert L. Carneiro.
4. *Adaptive strategies of Wakuenai peoples to the oligotrophic rain forest of the Rio Negro Basin*, by Jonathan Hill and Emilio F. Moran.
5. *Neotropical hunting among the Ache of eastern Paraguay*, by Kim Hill and Kristen Hawkes.
6. *Shotguns, blowguns, and spears: the analysis of technological efficiency*, by James A. Yost and Patricia M. Kelley.
7. *Why do the Mekranoti trek?* by Dennis Werner.
8. *Cocamilla fishing: patch modification and environmental buffering in the Amazon varzea*, by Anthony Stocks.
9. *Carpe Diem: an optimal foraging approach to Bari fishing and hunting*, by Stephen Beckerman.
10. *Adaptation and ethnobotanical classification: theoretical implications of animal resources and diet of the Aguaruna and Huambisa*, by Brent Berlin and Elois Ann Berlin.
11. *Nutrition in the northwest Amazon: household dietary intake and time-energy expenditure*, by Darna L. Dufour.
12. *Seasonal factors in subsistence, nutrition, and child growth in a central Brazilian Indian community*, by Nancy M. Flowers.
13. *The settlement pattern of a Yanomamo population bloc: a behavioral ecological interpretation*, by Raymond B. Hames.
14. *Village movement in relation to resources in Amazonia*, by Daniel R. Gross.
15. *The territorial dimensions of Siona-Secoya and Encabellado adaptation*, by William T. Vickers.

This book is important not only to students of the human ecology of the Amazon, but also to mathematically oriented human ecologists and ethnobiologists working in other geographical areas. Many of the articles contained here concentrate on quantitative methods of analyzing plant and animal resource utilization patterns, such as optimal foraging and linear programming, increasingly used in anthropological studies (see Smith 1983 for an excellent review).

In the introduction the editors present a brief summary of the history of cultural ecology in the Amazon Basin, along with a synopsis of recent theoretical and methodological advances in the field. Following this Johnson presents an energy input/output analysis of horticultural techniques used by the Machiguenga of lowland Peru, including descriptions of their clearing, planting, weeding, and harvesting techniques, and estimations of the amount of time the people allocate to each phase of this activity. This energy expenditure calculation is then compared to the nutritional benefits incurred from each crop produced. Also included in the article is a treatment of Machiguenga classification of soil and land-use types.

Carneiro next discusses the cultivation of manioc *(Manihot esculenta)* by the Kuikuru, including the techniques used in clearing fields, planting, cultivating, and processing the crop. He then estimates the amount of manioc produced by the village at 3.2 times the amount actually consumed by the group, using more refined techniques than in previous works, to correct an earlier estimate of 2.5 times (Carneiro 1957), and attempts to account for the excess crop produced. He also includes a summary of the Kuikuru classification of forest types and lists the native names for 46 different cultivars of manioc cultivated by the tribe.

The fourth article, by Hill and Moran, discusses the cultural mechanisms by which the Wakuenai have adapted to soil conditions poor even by Amazonian standards. These mechanisms include organization into patrilineal work groups and the establishment of internal redistribution systems.

The next article, by Hill and Hawkes, uses optimal foraging techniques to analyze hunting patterns among the Ache of eastern Paraguay. The authors discuss various techniques used by the Ache in hunting (shotgun, bow and arrow, etc.), and the amount of time allocated to each of several activities during the course of a typical week, along with the caloric returns to handling time for each species hunted. They use this data to postulate models from optimal foraging theory to explain differences in choices of prey depending on the type of hunting technique as well as potential explanations for differences in the sizes of hunting parties. Finally, they present and compare competing hypotheses concerning which of several objectives for maximization under which the Ache are operating (maximization of individual return vs. maximization of average return of the entire party, etc.).

Yost and Kelley subsequently compare the relative efficiency of shotguns vs. bows and arrows, using the Waorani of eastern Ecuador as their example. Their analysis includes a discussion of input/output ratios for each, and man weight per kill. They also discuss seasonal variation in hunting efficiency.

In the next article, Werner analyzes the trekking phenomenon among certain Amazonian tribes, especially the Mekronti-Kayapo of central Brazil. He concludes that the most likely explanation of this phenomenon is the quest for protein maximization, rather than an attempt to offset an otherwise temporarily short supply of protein, as others have suggested.

Stocks then discusses fishing practices of the Cocamilla of northeastern Peru, who fertilize the lake near their village with garbage, entrails, and human feces, and harvest fish from the lake during the season of highest water levels. This buffers environmental fluctuations and sustains optimal production throughout the year. The author cites this phenomenon as an example of Pyke *et al*'s (1977) "patch modification," and states that the Cocamilla most nearly fit Shoener's (1971) "time-minimizer" category, since they do not spend more time fishing than is neçessary to obtain the required catch.

The ninth article discusses the hunting and fishing patterns of the Bari of northeastern Venezuela from an optimal foraging perspective, concentrating on the central-place and patch-choice (i.e. marginal value theorem) branches of the field. Unfortunately, the author prefaces this with a glaring misstatement of the diet choice aspects of the theory. He states that optimal foraging theory postulates that a forager should harvest a particular species only if there is no other species available which would generate a higher return for time and energy invested. He believes that the Bari forage suboptimally since they continue to hunt despite the fact that they receive several times as much caloric return from fishing, a discrepancy which the author feels he must somehow explain. In fact, the diet choice model states that a foragers should continue to add species to its diet, in declining order of foraging efficiency, so long as the overall rate of return continues to increase (Pulliam 1974). Hence, diet choice depends not only on the relative efficiences of the various potential prey types, but also on the relative abundancies of prey items higher up on the list.

Berlin and Berlin, in the next article, evaluate various hypotheses to explain the fact that the Aguaruna and Huambisa Jivaro of northern Peru possess an elaborate taxonomy of a large number of zoological lifeforms while only utilizing a small fraction of these species. They eventually reject several adaptationist explanations in favor of a cognitive one, that the Jivaro, like modern taxonomists, are simply recording lexemically the variation and discontinuities present in the natural world.

The following two articles focus on nutrition. Dufour analyzes the dietary composition and time- and energy-budgeting patterns among the Tatuyo of Colombia, concentrating primarily on the caloric content of various wild and domesticated foods. The author mentions protein and micronutrients in the discussion, but presents no new information in this regard. Flowers presents a similar analysis of the Xavante, a group which was primarily dependent on wild foods until approximately 15 years ago, adding data on child nutrition and comparing these data to those gathered among other tribes such as the !Kung which have undergone similar transitions. The author concludes that the increased reliance on agricultural means of production does not seem to add to the reliability of food sources.

The final two articles deal with settlement patterns, Hames working with the Yanomamo of Venezuela and Gross with several tribes of central Brazil. Hames traces the gradual migration of a certain population of Yanomamo eastward through the course of several decades, and analyzes the causes of the migration from several perspectives, concluding that the primary reasons have to do with a shortage of mates rather than with scarcity of food resources. Gross tabulates emic reasons behind village movements given by informants of four different tribes, pointing out that missionary inducement, etc., are far more important than resource depletion from the natives' perspective. He then presents data on the nutrient composition of soils underlying native gardens before, during, and after swidden cultivation.

For the most part, the book is well written and well edited. The articles contained here should serve as an important starting point not only for those planning to work in the Amazon, but also for anyone interested in the various theoretical areas discussed in the book. My only complaints are that the subject matter seems a bit broadly based, with geography and the adaptationist approach being the only unifying similarities among the various papers. Some of the articles, particularly the more mathematically oriented ones, give no more than percusory hints at more extensive treatments of the theoretical aspects of their work published elsewhere (e.g., Johnson & Behrens 1982; Hames & Vickers 1982).

REFERENCES CITED

CARNIERO, Robert L. 1957. Subsistence in social structure: an ecological study of the Kuikuru Indians. PhD dissertation, University of Michigan.

HAMES, RAYMOND B., and WILLIAM T. VICKERS. 1982. Optimal diet breadth theory as a model to explain variability in Amazonian hunting. American Ethnologist 9:258-278.

JOHNSON, ALLEN, and CLIFFORD A. BEHRENS. 1982. Nutritional criteria in Machguenga food production decisions: a linear-programming analysis. Human Ecology 10:167-189.

PULLIAM, H. RONALD. 1974. On the theory of optimal diets. American Naturalist 108:59-75.

PYKE, GRAHAM H., H. RONALD PULLIAM, and ERIC L. CHARNOV. 1977. Optimal foraging: a selective review of theory and tests. Quarterly Review of Biology 52:137-154.

PYKE, GRAHAM H. 1984. Optimal foraging theory: a critical review. Annual Review of Ecology and Systematics 15:523-575.

SCHOENER, THOMAS W. 1971. Theory of feeding strategies. Annual Review of Ecology and Systematics 2:369-404.

SMITH, ERIC ALDEN. 1983. Anthropological applications of optimal foraging theory: a critical review. Current Anthropology 24(5):625-651.

Joseph E. Laferriere
Ecology & Evolutionary Biology
University of Arizona
Tucson, AZ 85721 USA

Book Review

Voir, savoir, pouvoir: Le chamanisme chez les Yagua du Nord-Est peruvien. (Vision, knowledge, power: shamanism among the Yagua of Northeast Peru). (1983) by Jean-Pierre Chaumeil. Paris: Editions de l'Ecole des Hautes Etudes en Sciences Sociales. Paper, 352 pp.

This book represents an in-depth, multi-faceted analysis of shamanism as practiced by the Yagua, a Native Amazonian people of Peru. The author adopts a holistic approach, stressing the importance of using both psychological and sociological approaches to understand this complex phenomenon.

In the introductory chapters the author reviews the history of anthropological theories on shamanism and briefly discusses the geographical location and ecological relationships of the Yagua. He then describes in some detail the ways in which shamanism is practiced in present-day Yagua communities. Numerous case studies of the experiences of individual shamans are included, and an account of the process of initiation of new shamans as related by one of the practitioners. This is followed by discussions of Yagua cosmology and the role of the shaman in it, and of the sociological roles played both by the shamans as individuals and by shamanism as an institutution. Included are analyses of ceremonies conducted by shamans, several of which are transcribed verbatim both in Yagua and in French, and of the position of the shaman in the internal hierarchy of the group and his role in violent confrontations.

The fourth chapter, entitled "Chamanisme et maladie (Shamanism and disease)", is particularly interesting because here the author discusses in some depth the Yagua concepts of disease causation, the role traditional medicinal practices play in curing illness, according to Yagua ideology, and the uses to which each of over 100 plants is put by shamans in their curing processes.

The book is remarkable for its thoroughness and for the author's willingness to analyze the subject from a wide variety of angles. This holistic approach gives the study a methodological importance far outweighing the empirical data alone.

Joseph E. Laferriere
Department of Ecology & Evolutionary Biology
University of Arizona
Tucson, Arizona 85721

Book Review

On the Trail of the Ancient Opium Poppy. Mark David Merlin, Associated University Presses, London and Toronto, 1984. pp. 324. $45.00.

The opium poppy, *Papaver somniferum*, source of the modified dipeptide we know as morphine, has profoundly influenced western culture. Morphine was first isolated in a crude form by Derosne, in 1803. The elucidation of its structure was a major goal not achieved until 1952, in the course of which new synthetic and degradative tools were evolved that shaped the evolving science of organic chemistry. Indeed, a complete issue of the prestigious Journal of the Chemical Society was devoted to the investigations of just one man, Perkins, on the structure of morphine. Sir Robert Robinson's acuity in proposing the structure or morphine 29 years before the correctness of his deduction was established led to new stereochemical insights, opened for investigation the field of alkaloidal biosynthesis, and fertilized the developing science of bio-organic chemistry. Within the last ten years, the extensive pharmacology of morphine has burgeoned into a new area of such vastness and importance that it threatens to swamp its parent: I am referring, of course, to the morphine-like peptides, the enkephalins and endorphins. These endogenous opioids exist in the brain (and gut), where the limits of their importance in central nervous systems functioning have yet to be defined.

Apart from their powerful analgetic activities, the opiates are addictive, this latter property, perhaps, impacting society even more markedly than the former, spawning massive social, legal and medical consequences. And let us not forget the literary heritage of the pale white poppy and its encapsulated metabolites. De Quincy's 'The Confessions of an English Opium Eater,' Dicken's 'Edwin Drood,' Cocteau's 'Opium, the Diary of a Cure,' Coleridge's 'Kubla Khan' and the bizarre Sherlock Holmes' mystery of 'The Man with the Twisted Lip' are a few of the stories that spring immediately to mind. A few more seconds thought, and one would have a library sufficient to solace many a winter's day.

The opium capsule is Janus-faced, being a source of oil as well as addiction. Poppy seeds and poppy oil have economic consequence even today, and perhaps early in the history, or prehistory of the poppy, nutrition may have been of more importance than the aspects of the poppy that are so significant for modern man.

Despite the salience of opium, and the vast literature on the subject, there have been few extended, coherent publications on the origins of the man-poppy relationship. 'On the Trail of the Ancient Opium Poppy,' by Mark David Merlin, fills this space on the shelf. This book provides the first overview on the possible origins of the poppy and its prehistoric associations with man.

The genus *Papaver* contains around 100 species, most of them found near the Mediterranean. Is our poppy, the heavy-capsuled, narcotic *Papaver somniferum*, a wild species, or is it an escaped cultivar? Is it, like corn or cannabis, one of those plants so useful to man, so domesticated, so cultivated, so selectively bred by man, that where it came from, and what it came from, are no longer easily discernable? Merlin addresses this question without unequivocally answering it. The differences between cultivated and uncultivated ecotypes are confusing. The subject is intrinsically complex, and may be beyond the skill of any one author to clarify. Practically, from the botanical viewpoint, it is not possible to distinguish precise varieties of *P. somniferum*. It is cultivated world-wide, but, despite the wide range of characteristics, the cultivars merge and hybridize without discernable boundaries. Merlin stresses the absence of truly wild populations of the poppy, and discusses, again without clear conclusion, theories concerning the relationship of *P. somniferum* and *P. setigerum*. These are the only poppies that contain morphine. *P. setigerum* grows wild around the Mediterranean. Are these two poppies independent species or not? If not, which is the father, which the son? The different chromosome numbers, *P. somniferum* having 2n=22 and *P. setigerum* 2n=44, have led some, such as Goldblatt, to propose that the latter is simply a polyploid form of the former. Others, such as Knörzer, hypothesize the opposite. Knörzer defends the onetime popular idea that *P. somniferum* was artificially selected from the wild *P. setigerum*, basing his position on the similarity of *P. somniferum* seeds from Neolithic sites to the seeds of modern *P. setigerum*. One might think it takes a brave man to draw major conclusions from two or three morphological characteristics of seeds abused, buried, dehydrated and charred over a period of several thousand years, particularly when the number of seeds available for analysis is low. But fortune smiles on the brave. Recent work suggests that chromosome number is not fixed for either of the 'species,' both producing diploid and polyploid plants.

Merlin's summary of this particular problem, on page 84, is masterly, but too judicial. He has a reluctance to impose his own viewpoint, his own conclusions, a virtue which however much one may admire in the abstract makes for an absence of signposts for the tyro. Being forced to draw one's own conclusions can make for tiring reading. It is made the more tiring by the delightful, but idiosyncratic, organization of the text, in which subject flows into subject in a stream of consciousness technique, and in which subheadings provide formal interruptions to the text but do not necessarily give information as to what is contained in it. Chapter 4, on 'The Prehistoric Use of the Opium Poppy' provides an example of authorial technique that is repeated in all other chapters. Here, despite the title, we meander through the structures of the alkaloids, their isolation and their pharmacological properties. Merlin accurately points out that the analgetic action of morphine is due to the lessening of apprehension rather than the abolishment of pain. Then we learn of the abuse that followed the two fold introduction of pure chemicals and hypodermic syringes. The significance of synthetic narcotics such as demerol is then touched upon, followed by a disquisition on how to cut a poppy capsule with a penknife. This, by some inexorable process, leads into a discussion of the founding of the Journal of Ethnopharmacology with extended accounts of the botanical distribution of mind-altering drugs and the use of cocoa, *Psilocybe* mushrooms, and the beautifully-flowered Texas mescalbean, *Sophora secundiflora*. Copious quotations from the appropriate authorities are interspersed. Then we find ourselves learning about earth goddesses and the relationship between the Roman and Greek gods. The question is posed, as has been posed for many a pharmacologically interesting plant, was the Ayurvedic *soma* an *Ephedra* species? This is all interesting, intriguing and confusing. We are traveling on no academic freeway, but hiking uphill through a thick forest. We are left to draw breath during one of the occasional platitudes scattered within the undergrowth of information. 'The opium poppy is one of the most widely known herbal drug plants.' 'The powerful modern opiate drugs and their chemical substituents were certainly not available to early peoples.' 'A particular use of a specific plant substance today does not necessarily confirm its application for similar purposes in antiquity.' True, true, and true.

Merlin is teased and tantalized by every glimpse of movement. He wants to develop ten themes at once. The information comes pouring out. There are several authorities, he gasps, and then lists 29 references, plus an 'etc.'. If the subtitles carry any reference to what comes under them, this appears to be due to chance rather than design. If we use chapter 4 as example, 'Ecological and Speculative Considerations' immediately gallops off into a full-scale discussion of *Cannabis sativa*, the various products of which chafe men's necks, promote good fellowship and small testicles, and provide an excellent edible oil. Hemp and opium poppies are both weeds, we are told. But what is a weed? A detailed definition follows.

In chapter 5, we have a full discussion of the archeological record for poppies in Europe, mixed in with a satisfying drawing of *Chenopodium album*, a photograph of poppy seed pastry (and very nice it looks) complete with recipe, and a discussion as to why prehistoric lake shore dwellers dwelt on lake shores rather than on firmer land.

In short, this book reminds me of the comment of Marshall Bosquet: 'C'est magnifique, mais ce n'est pas la guerre'. Merlin is an encyclopediac investigator, a polymath of impressive scholarship. He is equally at home discussing etymology, criticizing Thompson's tranlations of Assyrian texts, explicating bronze age trade or examining the cultural underpinnings of Minoan civilization. He does not necessarily achieve coherence, but his book is a storehouse crammed with delights, with the information density of a hard disc.

Was the opium poppy a creation of an eastern or western culture? I still do not know, and doubt if anyone does. Merlin, however, succeeds in demonstrating that shards of fact can be used to create whole china shops of speculation in archeology and archeobotany. One of his few concrete suggestions is that the sea-trading Minoans introduced the poppy into the eastern Mediterranean where the evolving Hellenic culture made the plant its own, along with the grape and olive. Other authors (e.g. Daumas, la civilization de l'Egypte pharonique, 1965) have suggested that opium was used in Egypt as early as the 18th Dynasty (BC 1590-1340), and this could have provided a source for later cultures.

The style of the book varies from the condensed and expressive ('It is an outstanding feature of the Mycenean culture that we know so little about so many aspects of it.') to a standard, workmanlike prose that gets the job done. Jargon and the linguistic excesses of the social sciences are eschewed, the compound nouns and polysyllabic backformations marring so much academic prose being absent. Merlin's allusive style, with his reluctance to draw conclusions for the reader, can be illustrated by an extended quotation:

> 'An interesting point made by Greig and Turner concerns the rise and fall of olive cultivation and its relative importance in ancient Greece. During the Peloponnesian Wars, the Spartan army attacked the Athenian olive groves: ". . . and this may not have been the first time that olives had been a target of hostilities." It is important to remember that olives were most probably a major oil source for the Myceneans as they were among the later Greeks. In this case, what substitute could have replaced the oil extracted from olives? If importation of olive oil from an external source was precluded during the non-productive replanting period, then perhaps a locally produced vegetable source was required and utilized. Even if the importation of organic oil resources was not curtailed, it may not have been olive oil that was imported. The pollen diagrams examined by Grieg and Turner Indicate that olive cultivation in Macedonia was intermittent, with two well-defined periods.'

Halfway through the paragraph, it begins to dawn on the reader that this apparent diversion is making the point that poppy seeds may have been a major source of oil in Periclean Greece. This point is buttressed by appeal to data from an earlier culture, the Mycenean, and a later one, the Macedonian. Nowhere, however, is the point explicitly stated. The reader is left to draw the conclusion for himself. This passage also illustrates some flaws of economy, which tire the reader, in the generally acceptable style: organic oil resources (oil); oil extracted from olives (olive oil); importation from an external source (importation); target of hostilities (target). A poor ear is suggested, for example, by the seven jangling p's in one sentence.

But these are mere quibbles, cavils, inconsequential things. In this book we have a magnificent contribution to a complex subject; a source that will be utilized by other investigators over the coming decades. The illustrations, although poorly reproduced, are copious and well chosen. No review can hope to capture the complexity and density of the book. At one point, Merlin refers to Heinrich Schliemann, the discoverer of Troy, that Homeric site where unbridled passion for another's wife lead to a nine year seige, ending in the burning of 'the topless towers of Ilium'. Schliemann has been described as turning legend into history. I venture to suspect that Merlin, too, has turned legend to history in this masterful and scholarly volume.

Ryan J. Huxtable, Ph.D.
Department of Pharmacology
University of Arizona Health Sciences Center
Tucson, Arizona 85724

NEWS AND COMMENTS

SOCIETY OF ETHNOBIOLOGY CONFERENCE COORDINATOR

The Editorial Board, at its annual meeting on May 7, 1985, created a new position within the Society—Conference Coordinator. Jan Timbrook was asked to assume this position and the Board is pleased to announce that she has accepted. Part of the responsibilities of this position is to assist the local committee in the planning of the annual Conference. Guidelines and a time schedule are in the final stages of development. Since Jan will be in frequent contact with the local committee each year, she can be contacted for information: Jan Timbrook, Department of Anthropology, Santa Barbara Museum of Natural History, 2559 Puesta Del Sol Road, Santa Barbara, CA 93105. Telephone: (805) 682-4711.

GUINDON

"Cow's gone crazy! She believes they're going to kill and eat everybody but the dog."

By permission of New America Syndicate

ANNOUNCEMENTS

The School of American Research announces four post-doctoral resident fellowships to be awarded for the 1986/87 academic year to scholars in anthropology and related disciplines. These fellowships are supported by the Weatherhead Foundation and the National Endowment for the Humanities—and provide a monthly stipend, housing, a private study, and the time, space and quiet needed for creative research. The application deadline is the first of November, 1985. Write to the Resident Scholar Program there, at P.O. Box 2188, 660 Garcia Street, Santa Fe, NM 87501, or call Susan Bodenstein at (505) 982-4987.

Native Seeds/S.E.A.R.C.H. has issued its catalog of "Ancient Seeds for Modern Seeds" (available at 3950 West New York Drive, Tucson, AZ 85745). Native Seeds/S.E.A.R.C.H. [What does the acronym stand for?] is a non-profit outfit dedicated to preserving the Native American crop heritage, with a primary focus on the Greater Southwest. "We are proud to present to you the largest selection ever offered of native crop seedstocks from the Greater Southwest. These ancient crop varieties are nonhybrid, open pollinated seed, some having remarkable levels of tolerance to drought, heat, salinity, root knot nematodes and certain pathogens; others have higher protein and mineral contents than related commercial varieties . . . In order that this native American crop heritage will not be forgotten nor abandoned, we are offering small samples of these seeds for distribution to anyone interested in diversifying their gardens." Associate memberships are solicited at $10/year (members receive *The Seedhead News*) to help support this effort. Seeds available include amaranths, a large variety of *Phaseolus* beans and of corn (including *Zea diploperennis*), chiles, squashes, cotton, gourds, and tobacco.

GENE SPLICING UPDATE

As noted in this column in the last issue, genetic engineering experiments are the target of a crusade by Jeremy Rifkin, who fears that unexpected and unfortunate consequences may result from the release of such "unnatural" organisms into the environment. Rifkin sued the National Institutes of Health in 1983 to halt the field testing of genetically modified bacteria (designed to prevent frost formation on plants) by University of California researchers. In May of 1984 Federal District Judge John Sirica enjoined NIH from permitting the experiment until an environmental assessment was completed. The U.S. Court of Appeals last February reviewed Sirica's decision and upheld his ruling in part. Notably, the Appeals Court noted that "NIH has not yet displayed the rigorous attention to environmental concerns demanded by law, and that the deficiency rests in NIH's complete failure to consider the possibility of various environmental effects" if the bacteria proved capable of dispersal and survival in nature. Still at issue is whether each experiment should require a rather cursory "environmental assessment" or whether a comprehensive environmental impact statement needs to be prepared covering the potential impact of the release of altered organisms in general. In response, biotechnology firms are submitting their proposals directly to the Environmental Protection Agency for review. (Marjorie Sun, *Science,* 15 March 1985, pg. 1321.)

ETHNOBIOLOGY IN THE NEWS

"Frog-leg Cuisine Blamed for Environmental Crisis": this *Seattle Post-Intelligencer* headline last March 31 caught my eye. I read further. It seems that the frogs' legs consumed by epicures in Europe, Australia, and the United States—from some 200 million frogs annually—are not supplied by harvesting the bullfrogs that infest your local wetland. Rather, the preferred species are *Rana tigerina* and *R. hexadactyla,* most imported from Bangladesh and India, with substantial imports as well from Indonesia. The World Wildlife Fund is concerned at the prospects for ecological catastrophe that may result from this decimation of local anuran populations. "Their natural prey—insects—are breeding out of control . . . , triggering an ecological chain reaction and posing a serious threat to agriculture . . . To combat the insects, farmers . . . are using more and more . . . insecticides such as DDT, . . . banned in the West."

Donald Ugent, specialist in ancient potato studies at Southern Illinois University, claims to have discovered remains of cultivated potatoes 10,000 years old, equal in age to the earliest remains of domesticated wheat from the Near East. The discovery in the Chilca Canyon of Peru is from a desert area that was once fertile. (*Seattle Post-Intelligencer,* 26 March 1985.)

Wade Davis, a Harvard University botany student, has recently returned from Haiti having "unmasked [the] mystery behind zombies" (*Seattle Post-Intelligencer,* 24 March 1985). According to Davis, "Zombies are not people who have risen from the dead. Instead, they are people who have been given a drug that mimics death." Davis, whose studies were sponsored by the Harvard Botanical Museum, attributes this effect to the poison tetrodotoxin, extracted from pufferfish. It is "500 times more powerful than cyanide . . . A drop on the head of a pin is enough to kill." This poison is incorporated in a formula which includes parts from toads, sea worms, lizards, tarantulas, and human bones. Ground into the skins of victims, it results in paralysis and a drastic lowering of blood pressure within six hours. Paralyzed victims are buried, then disinterred and administered an "antidote," which Davis believes serves rather to induce amnesia and psychological dependency in the victim. This drastic treatment is normally reserved for those accused and convicted before a voodoo tribunal of violations of voodoo codes prescribed by this "sophisticated religion with African roots." Details to be published in the *Journal of Ethnopharmacology.*

CREATIVE APPLIED ETHNOZOOLOGY DEPARTMENT

From an ad in *Alaska Magazine*, April 1985, advertising "Dr. Juice One Drop Fish Scent" (available from Blue Fox Tackle Company, 645 North Emerson, Cambridge, MN 55008): "In 1978 an American anthropologist named Dr. Gregory Bambanek, M.D., was studying the primitive people of Central America. They are the mixed blood descendants of English pirates, Mayan Indians and African slaves. There is powerful magic there . . . He befriended the medicine man, Dzacar, who not only healed the sick but kept the healthy well-fed. In this meat-poor tribe, Dzacar was the number one fisherman . . . Dzacar's magic was in his uncanny ability to catch fish on nothing but a hook, line and a shred of cloth. With this unlikely rig, he would pole out into the tropical river and return with snook, tarpon and bandarootoo . . . It was one such night that Dr. Gregory Bambanek, himself a fisherman, went along with Dzacar and first got a whiff of the potent stuff Dzacar had on that lure . . . What Bambanek brought home was a secret formulation of scents derived from living jungle plants, fish and animals. Back in America, in his laboratory, he analyzed the chemical makeup of the potion . . . *Kairomones* were the scientific base of the formula. To the gamefish, this hormonal substance indicates a living organism such as live baitfish . . . By dialing in other hormonal "communicators" he found he could send other messages like a hot line to the fish's brain . . . He added *Fear Pheromones*, the smell of fear given off by prey species that attracts and excites predators. He added *Schooling Pheromones*, the scent baitfish use to home in on their school and gamefish use to find them. He added traces of *Sex Phermones* which, in small doses, make gamefish very aggressive and territorial . . . And finally he added *Attractant Amino Acids* which camouflage the repellent scent of human finger prints without alerting the fish to any smell out of the ordinary . . . Incredibly, in a dilution of one part per 10,000,000,000, Dr. Juice Fish Scent will register its powerful messages of food, fear and sexual aggression deep in the fish's brain, triggering the desired strike response . . . Outdoor Life called it, 'a far cry from the run-of-the-mill, anise oil based, licorice-smelling fish 'attractors' ' . . . Available in 9 formulations for the 9 most popular species of gamefish. Unless you have a taste for bandarootoo." [This ad copy strikes me as a literary analog of Dr. Juice Fish Scent, designed to lure fishermen, "registering powerful messages . . . in the [fisherman's] brain . . . [and] triggering the desired strike response," ed.]

Society of Ethnobiology
1986
Annual Meeting Notice

The 9th Annual Meeting of the Society of Ethnobiology will be held on the campus of the University of New Mexico on March 20-22, 1986. Further details and the call for papers will be mailed to the membership of the Society about the 1st of November, 1985. If you don't receive yours, or need more information, please write:

Castetter Laboratory
for Ethnobotanical Studies
Department of Biology
University of New Mexico
Albuquerque, New Mexico 87131

or call: 1-505-277-3348

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed doubled-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as *bold-face italics* to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses*, i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Department of General Biology
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

With Volume 3, Number 1, the editors of the *Journal of Ethnobiology* added a book review section. We welcome suggestions on books to review or actual reviews from the readership of the *Journal*. Please send suggestions, comments, or reviews to Charles H. Miksicek or Richard S. Felger, Office of Arid Lands Studies, University of Arizona, Tucson, Arizona 85721.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Steven D. Emslie, Department of Zoology, University of Florida, Gainesville, Florida 32611. Subscription rates are $25.00, institutional; $15.00 regular members, for U.S., Canada, and Mexico; foreign subscribers add $6.00. Write checks payable to *Journal of Ethnobiology*. Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

CONTENTS

Journal of Ethnobiology

VOLUME 5, NUMBER 2

WINTER 1985

Journal and Society Organization

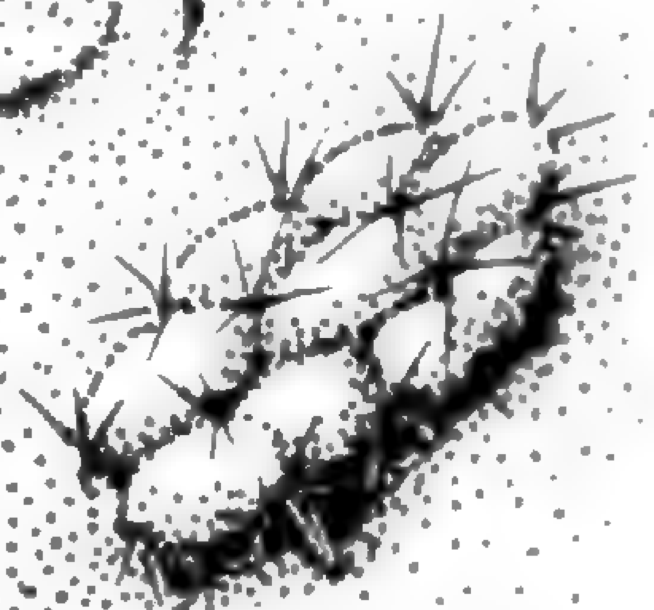
Journal of Ethnobiology is published semi-annually. Manuscripts for publication and information for the "News and Comments" section should be sent to the appropriate editor on the inside back cover of this issue.

ISSN 0278-0771

Journal of Ethnobiology

VOLUME 5, NUMBER 2 WINTER 1985

SKETCHES IN THE SAND



Play is a necessary part of the creative process, and, we've been told that if you cannot play with your material and resources, it's unlikely that creative ideas will be generated. Those of us living within reasonable driving distance of Albuquerque, New Mexico who choose to "carpool" to the Ethnobiology Conference there have an opportunity to have fun—to play—with ethnobiological word games. Insight and new patterns of information are likely to surface. Here are some games I have enjoyed in the past.

Twenty Questions. As a botanist I have most frequently played "Botanical" Twenty Questions. It's interesting to observe yourself becoming increasingly adept at getting the most mileage out of a question. For example, it's better to ask "Does your plant require double fertilization?" than "Is your's a seed plant?" And, since variety is the spice of life, it becomes more interesting to ask "Does your plant belong to a largely wind pollinated family?" instead of "Is your plant in the Compositae?" With a little thought, one can easily play Ethnobiological Twenty Questions.

Tom Swifties can be fun, and modified for ethnobiology, a challenge. Browsing through recent issues of the *Journal* brought forth these rather obvious examples. Perhaps you will find more exacting ones. Have you ever heard:

A tree ring? (Swetnam, 4:77-199, 1984).

A birch bark? (Holman and Egan, 5:65, 1985).

Have you ever seen:

Data bank? (Shuster and Bye, 3:157-174, 1983).

A seed bank? (News and Comments, 5:83, 1985).

Malapropisms, modified for ethnobiology, may be more difficult than Tom Swifties and, once started, perhaps more satisfying. A malapropism is the inappropriate or incorrect use of a word, and in the play from which the term was coined, Mrs. Malaprop—quite accomplished at this questionable art—told her daughter that it was impolite, when surprised, for her mouth to be open like an allegory. As an editor, I have been remiss in allowing the inappropriate use of "methodology," which means something other than a description of the methods used in a study. This malapropism is not humorous because we do not preceive that it is illogical. It's in the same category as saying "Excuse me, I must take my medication," and then swallowing a pill. Admittedly, both methodology and medication sound more involved and hence, I suppose, more important or more "scientific," than method and medicine, and, in most instances, the simpler word is the appropriate one. (All of this reminds me of a friend who, on a recent trip to England, just had to try scones because the word sounded so elegant. He concluded that elegantly though the word may sound as it falls from the lips, they are, afterall, simply soda biscuits and, in his opinion, not all that pleasing to the palate.) To return to malapropisms, I'm sure you can find or think of many that are humorous.

Composing limericks is, for some, a greater challenge than any of the amusements mentioned above because of rhyme and meter requirements. In keeping with the thesis in the paper by Farrington and Urry (this issue) and with a plea for forgiveness from the Muse of Poetry, I offer this untitled piece.

A woman with pretty beans in her nose
Asked "Why must I go where this grows?"
So she buried a seed
And before long indeed
She had enough for her fingers and toes.

Perhaps some of your efforts will be suitable for inclusion in Gene Hunn's column, News and Comments, in the *Journal.*

W.V.

J. Ethnobiol. 5(2):87-100 Winter 1985

NUTRIENTS IN NATIVE FOODS OF SOUTHEASTERN ALASKA

HELEN M. DRURY
Mt. Edgecumbe Native Hospital
Alaska Area Native Health Service
Indian Health Service
Mt. Edgecumbe, Alaska 99835[1]

ABSTRACT.—Cultural, health and ecological concerns have stimulated interest in learning the nutrient content of the foods of southeastern Alaska coastal Native Americans. Twenty foods indigenous to southeastern Alaska were analyzed for proximate composition, two minerals and five vitamins. Many traditional foods are still eaten by southeastern Natives and the nutrient values determined in this study showed that these foods can make important dietary contributions. Seafoods such as seaweeds and marine animals are excellent sources of certain minerals and vitamins: eulachon, leather chiton, and cockles are high in iron; leather chiton, the seaweeds and hard dried sockeye salmon are good sources of calcium; eulachon has a high level of vitamin A. Other wild plant foods also make valuable nutritional contributions.

INTRODUCTION

Throughout history Native populations have subsisted on those foods indigenous to their local environments. Intimate knowledge of many foods edible within a territory was imperative for survival. Native peoples of the northwest coast of North America had particularly rich food supplies. The cool-temperate rain forest environment, with an annual precipitation in excess of 200 cm, produced an abundance of many kinds of berries, roots and greens. The beaches and waters teemed with fish and other marine and freshwater life. Game animals and birds were also available (Underhill 1945, Drucker 1955).

When trade with the Europeans began in the late 1700's flour and sugar were introduced. For a considerable period of time use of "white man's foods" was limited and any effect on health was not recorded. However, in 1933 a dentist working among Alaskan Eskimos and Indians noted changes in their dental health (Price 1939). Since World War II, use of "outside foods" rapidly increased. Heller (1964) reported that in the north of Alaska the Eskimo population had increased its intake of carbohydrate calories from an estimated 2 to 11% in aboriginal days to approximately one-third of the total calories and had also increased intake of saturated fats. Schaeffer (1971) also made a comprehensive report on the effects of similar major dietary changes among Canadian Eskimos. Because these changes have apparently resulted in increasing health problems for Alaska's Natives, consideration is being given to what can be done to improve the situation. Increased knowledge of traditional foods is a starting point for nutrition education programs suited to native people.

PRESENT DAY CONCERNS

Southeastern Alaska is a rugged island archipelago extending from Annette Island in the south to Yakutat in the north. Of a total population of approximately 50,000, nearly 10,000 are Native, belonging to three groups: the Tlingit, Haida and Tsimpshean (tribal spelling), of which the Tlingit is the largest. Their foods are quite similar but variations in preferences occur. Typical of most cultures, these people have high regard for their traditional foods but have had feelings of inferiority about them for many years because the Caucasian community has regarded many of them as strange.

Despite the large number of wild foods available, little is known about their nutrient content. Researchers have cited the lack of nutritional information on the foods of other Native groups (Benson et al. 1973, Kuhnlein et al. 1979). Regard should be given to the resurgence of cultural pride which has intensified Native interest in obtaining such information. In addition, health workers could frequently use such facts when treating Native clients.

Because of a desire to stimulate recovery of old knowledge of their culture, as well as to consider ways to decrease the incidence of obesity, coronary disease, hypertension and diabetes, the Southeast Alaska Regional Health Corporation, a Native organization, sought and obtained funds from the State of Alaska in 1980 to perform these nutrient analyses of twenty southeastern Alaska Native foods.

Limited nutrition information for some of these foods can be found in USDA food composition tables (Watt and Merrill 1983). However, the data are often incomplete. The National Marine Fisheries Service has reported nutrient values of many marine animals in the raw state (Sidwell et al. 1974, 1977, 1978a, 1978b). Heller and Scott (1967) have reported information on foods utilized by Natives in the northerly regions of Alaska. Turner studied the plant foods of British Columbia Native, but a detailed nutrient analysis for most southeastern Alaska Native foods has not be available.

METHODS

Eight southeastern Alaska Natives, from six different towns, and recognized by the Native community to be knowledgeable about wild foods, were contacted for information and suggestions about foods to be collected for the analysis. Most foods, so identified, had a long history of use, although styles of preparation have changed over the years. A list of 20 foods was made from the recommendations of these people.

Nomenclature for wild foods can be a problem because common names often vary from one village to the next. The ten Native villages of this panhandle portion of Alaska are in isolated locations on the numerous islands that characterize the study area. These villages are seldom connected by roads so float planes or boats are the primary means of transportation. Certain types or styles of food preparation may be more popular in one community or area than another. At the same time, there are also individual differences within each community. Most common names used in this study are those that have widest usage. In one instance, to avoid misunderstanding, the term "leather chiton" is used instead of "gum boots", which is the name used by Natives. Scientific identification of vascular plants was made by Mary Muller, U.S. Forest Service botanist for the Tongass National Forest.

Twelve of the foods analyzed were obtained in the Haida village of Hydaburg. The remainder were provided by individuals in Sitka and Ketchikan. Remoteness, travel complications, communication problems, all peculiar to Alaska, caused collecting difficulties.

Each sample, except the eulachon fat, was prepared at the home of the donor for family use. At the time of collection, all donors were queried about how the food had been prepared. All donors were individuals with a good knowledge of sound food preservation techniques. All indicated that their foods had been prepared promptly after being harvested (Table 1).

COLLECTION AND PREPARATION OF FOODS

Each foods was collected by the author at the home of the donor. The donor had previously frozen or otherwise preserved the food but the author did not participate in or observe any of the food preservation.

TABLE 1.–Dates of harvesting, amount, shipment, analysis, preparation, and point of collection of 20 southeastern Alaska Native foods.

Date	Amount	Food	Activity	Preparation	Point of collection
Spring 1979	85 g	ribbon seaweed	harvested	dried	Sitka
Spring 1980	454 g	herring eggs (2 samples)	harvested	frozen	Hydaburg
	170 g	black seaweed		dried	Hydaburg
	454 g	sea cucumber		frozen	Hydaburg
	454 g	eulachon		dried, frozen	Ketchikan
	454 g	eulachon fat		fermented, frozen	Hydaburg
	454 g	octopus		frozen	Ketchikan
	454 g	cockles		frozen	Hydaburg
	454 g	salmonberry		frozen	Sitka
Summer 1980	454 g	blueberry	harvested	frozen	Sitka
	454 g	huckleberry		frozen	Sitka and Hydaburg
		beach asparagus		frozen	Hydaburg
	454 g ea.	salmon (4 samples)		3 canned, 1 dried	Hydaburg/ Ketchikan
	454 g	venison		frozen	Hydaburg
December 1980			17 foods shipped to laboratory		
January 1981			17 foods analyzed		
Spring 1981	454 g	leather chiton	harvested	frozen	Sitka
	454 g	fern fiddlehead		frozen	Sitka
Spring 1981		leather chiton	shipped and analyzed		
		fern fiddlehead			
	85 g	ribbon seaweed		dried	
	454 g	salmonberry		frozen	Sitka
	454 g	blueberry		frozen	Sitka
	454 g	huckleberry		frozen	Sitka

Herring eggs on kelp, herring eggs on hemlock branches, leather chiton and berries were kept frozen in plastic bags with no other treatment before the nutritional analysis. Since herring eggs which have been deposited on kelp are eaten with the kelp, the kelp was included in this sample. This is not the case when the eggs have been deposited on hemlock branches. In this instance the eggs alone were analyzed after being removed from the branches at the lab. Sea cucumber, venison and octopus were eviscerated and frozen. Fern fiddleheads and beach asparagus were blanched, then frozen. Cockles were steamed, removed from the shell, then frozen. Seaweed was dried after collection and stored in plastic bags in a cool, dry place. All other foods were in one pound (454 g) amounts.

The samples of salmon were each prepared with a different variation. Most Native women do not use measuring cups and spoons or check temperatures during drying and smoking. Ingredient amounts are estimated. One donor estimated her smoking temperatures varied from 48° to 74° C. The smoked, canned king salmon was prepared using a brief immersion in a salt water solution that "contained enough salt to float a potato" (355 ml/3.8 l water, determined later by the author), then smoked 1.5 days and canned.

The "kippered" king salmon had been marinated for about ten minutes in a salt solution which contained brown sugar and soy sauce. Sometimes soy sauce is substituted for all or part of the salt solution. Brown sugar may be used with approximately equal amounts of salt, i.e. 118 ml salt, 118 ml brown sugar/.95 l water. After the marination period the fish was hung for approximately six hours or overnight, until it had a glazed appearance indicating the desired degree of dryness. The donor of the kippered king salmon said the fish was smoked for two days, then put into cans and processed at 10 pounds pressure for 60 min.

Another donor used a considerably different procedure for her kippered sockeye. It had been soaked for about three hours in a sugar-salt brine. She used a longer soaking period because she used "less salt than many women." She chose not to state amounts used. After the marinating period the salmon was smoked at a "very controlled heat to avoid overcooking the fish". Following the smoking process it was canned.

The "hard-dried" sockeye was the only salmon sample not home canned. It was briefly marinated in a brine solution, ("enough salt to float a potato") followed by a very slow alder and spruce smoke for a week. A long period of smoke was used because smoking was to be the primary means of preservation with no further canning or freezing anticipated. This salmon sample was frozen after it was received from the donor and kept frozen until the lab analysis, simply because that was the most convenient way to hold it. "Hard-drying" is the "old way" of preserving salmon. Fish prepared by this method would normally be stored in a cool, dry location.

The dried eulachon had been eviscerated and left whole, marinated in the brine solution ("enough salt to float a potato"), then smoked and hard dried for four to five days. Since eulachon are much smaller than salmon, "hard smoking" can be achieved in less time than is required for salmon.

The donor of the eulachon oil had purchased the home canned oil from a friend, then stored it in her home freezer. She thought the eulachon had been fermented first, then cooked, in order to render the fat because "that was the way it was usually done." This was the only information available regarding the sample. Instead of the routine nutrient analysis done on all the other foods, a fatty acid analysis and vitamin A test were performed on the eulachon oil.

The venison sample provided to the author had been ground then frozen for a home freezer. It is unknown which parts were included in the sample. Because of extremely high shipping costs and limited storage facilities all the foods were collected and stored in a home freezer at -18° C in Sitka, then sent to the Columbia Laboratories in Corbett, Oregon via air express on two separate dates (Table 1).

LABORATORY ANALYSIS

Analyses were performed by Columbia Laboratories on foods as they were received, without treatment such as washing. Since these foods were considered ready to eat by the persons preparing them, this seemed acceptable.

In most cases the samples were ground with the use of a food processor until they were visually homogenous. Except for berries, multiple tests and statistical tests were not done.

Limits of detection were approximately:

Protein	0.2%	Iron	0.1 mg/100 g
Fat	0.05%	Vitamin A	20 IU/100 g
Carbohydrate	0.5%	Thiamin	0.01 mg/100 g
Moisture	0.5%	Riboflavin	0.01 mg/100 g
Ash	0.05%	Niacin	0.1 mg/100 g
Calcium	1.0 mg/100 g	Ascorbic Acid	0.5 mg/100 g

Tests performed by Columbia Laboratories followed procedures outlined by the 12th and 13th editions of the Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC)(Horowitz, W. 1975, 1980). Taken from the 12th edition: moisture (24.003), vitamin A (43.014-.017) (FAO/WHO distribution factors for Vitamin A activity are included in AOAC methods), vitamin C (43.056-3.062), thiamin (43.024-43.038) and riboflavin (43.039). Taken from the 13th edition: protein (2.055-2.057), fat (14.019), ash (14.006), and calcium (7.091-7.094 (a), 7.095). The calcium determination involved dry ashing the sample, dissolving the ash in dilute hydrochloric acid, lanthanum added to minimize interferences, final determination by atomic absorption spectrophotometry. In the iron analysis (7.091-7.094 (a), 7.095), the sample was dry ashed, the ash dissolved in dilute hydrochloric acid, and the determination made by atomic absorption spectrophotometry. Carbohydrate values were calculated by difference. AOAC Kjeldahl procedure was used to estimate protein. Nitrogen was multiplied by 6.25 to estimate protein. Factors used to estimate calories were: protein 4, carbohydrate 4, fat 9 kcal/g.

The laboratory reported Vitamin A as International Units of retinol or carotene, depending on individual food content. Conversions to Retinol Equivalents by use of these conversion factors (Pike and Brown 1975):

$$1 \text{ mg RE} = 10 \text{ IU of beta carotene}$$

$$1 \text{ mg RE} = 3.33 \text{ IU of retinol}$$

Where foods contained both retinol and beta carotene:

$$\frac{\text{IU beta-carotene}}{10} + \frac{\text{IU retinol}}{3.33} = \text{RE}$$

RESULTS AND DISCUSSION

The analysis of twenty southeastern Alaska Native foods has provided data that show these foods are valuable sources of important nutrients. Table 2 shows the proximate composition and content of two minerals and five vitamins for 100 g of edible foods. Figure 1 shows kilocalorite content of these foods. Figure 2 presents the fatty acid content of eulachon fat.

TABLE 2.—Nutrient composition of 20 southeastern Alaska Native foods.

Prepared Food (100 gm), E.P.	Kilocalories	Protein g	Fat g	Carbohydrates g	Moisture g	Ash g	Calcium mg	Iron mg	Vitamin A RE	Thiamin mg	Riboflavin mg	Niacin mg	Ascorbic Acid mg
(a) Plant foods													
Beach asparagus, glasswort, *Salicornia Pacifica*, frozen, thawed	27	1.8	0.3	4.3	91.1	2.5	45	0.9	192	0.01	0.09	0.7	1.8
Fern fiddlehead, *Athyrium filix-femina*, frozen, thawed	34	3.2	0.2	4.9	91.1	0.6	23	0.8	134	0.00	0.25	2.0	8.9
Black seaweed, *Porphyra* cf. *laciniata*, dried	298	28.7	2.0	41.3	9.2	18.8	157	10.4	472	0.11	2.25	11.5	17.4
Ribbon seaweed, *Palmaria* sp., dried	323	19.9	0.6	59.5	7.2	12.8	190	11.0	2	0.07	1.00	6.9	4.8
Blueberry mixture, *Vaccinium alaskanese*, *V. ovalifolium*, frozen, thawed	44	0.7	0.0	10.4	88.7	0.2	15	1.1	16	0.03	0.10	0.4	2.2
Huckleberry, *Vaccinium parvifolium*, frozen, thawed	37	0.4	0.1	8.7	90.7	0.1	15	0.3	8	0.01	0.03	0.3	2.8
Salmonberry *Rubus spectabilis*, frozen, thawed	44	1.0	0.1	10.0	88.6	0.4	14	0.6	155	0.04	0.07	0.1	2.4
(b) Animal foods													
Herring eggs, *Clupea pallasii*, plain, raw, frozen, thawed, removed from hemlock branches (*Tsuga heterophylla*)	56	9.6	1.0	4.4	83.8	2.2	19	2.7	6	0.10	0.12	1.8	0.6
Herring eggs on kelp, giant kelp, *Macrocystis integrifolia*, raw, frozen, thawed	59	11.3	0.8	2.6	81.8	3.9	161	3.4	9	0.10	0.13	2.7	0.0
King salmon, *Oncorhynchus tshawytscha*, smoked, canned	150	23.2	5.9	1.0	66.7	3.2	60	1.8	84	0.01	0.10	8.5	0.0

King salmon, kippered, canned	266	30.7	15.9	0.0	51.2	2.5	38	1.7	15	0.05	0.14	10.9	0.0
Sockeye salmon, *Oncorhynchus nerka*, kippered, canned	190	29.5	7.7	0.7	59.1	3.0	68	1.3	0	0.02	0.22	13.9	0.0
Sockeye slamon, hard dried	371	57.2	14.4	3.2	20.3	4.9	136	1.9	82	0.14	0.60	20.2	0.0
Octopus, *Octopus dofleini*, raw, frozen, thawed	57	11.9	0.6	0.9	84.4	2.2	24	5.3	0	0.03	0.04	2.1	0.0
Cockles, *Clinocardium nuttallii*, steamed, frozen, thawed	79	13.5	0.7	4.7	78.8	2.3	30	16.2	0	0.01	0.20	3.2	0.0
Sea cucumber, yane, *Stichopus californicus*, frozen, thawed	68	13.0	0.4	3.1	80.7	2.8	30	0.6	77	0.05	0.94	3.2	0.0
Leather chiton, gumboots, *Katharina tunicata*, raw, frozen, thawed	83	17.1	1.6	0.0	78.6	3.7	121	16.0	495	0.05	0.34	4.2	0.0
Eulachon, smoked, *Thaleichthys pacificus*	308	20.5	24.8	0.8	50.1	3.8	30	12.2	1183	0.02	0.88	5.5	0.0
Eulachon, fat, fermented, frozen, thawed									1697				
Venison, Sitka deer, *Odocoileus hemionus sitkensis*, raw, frozen, thawed	117	21.5	3.4	0.2	73.7	1.2	7	2.9	0	0.2	0.36	6.6	0.0

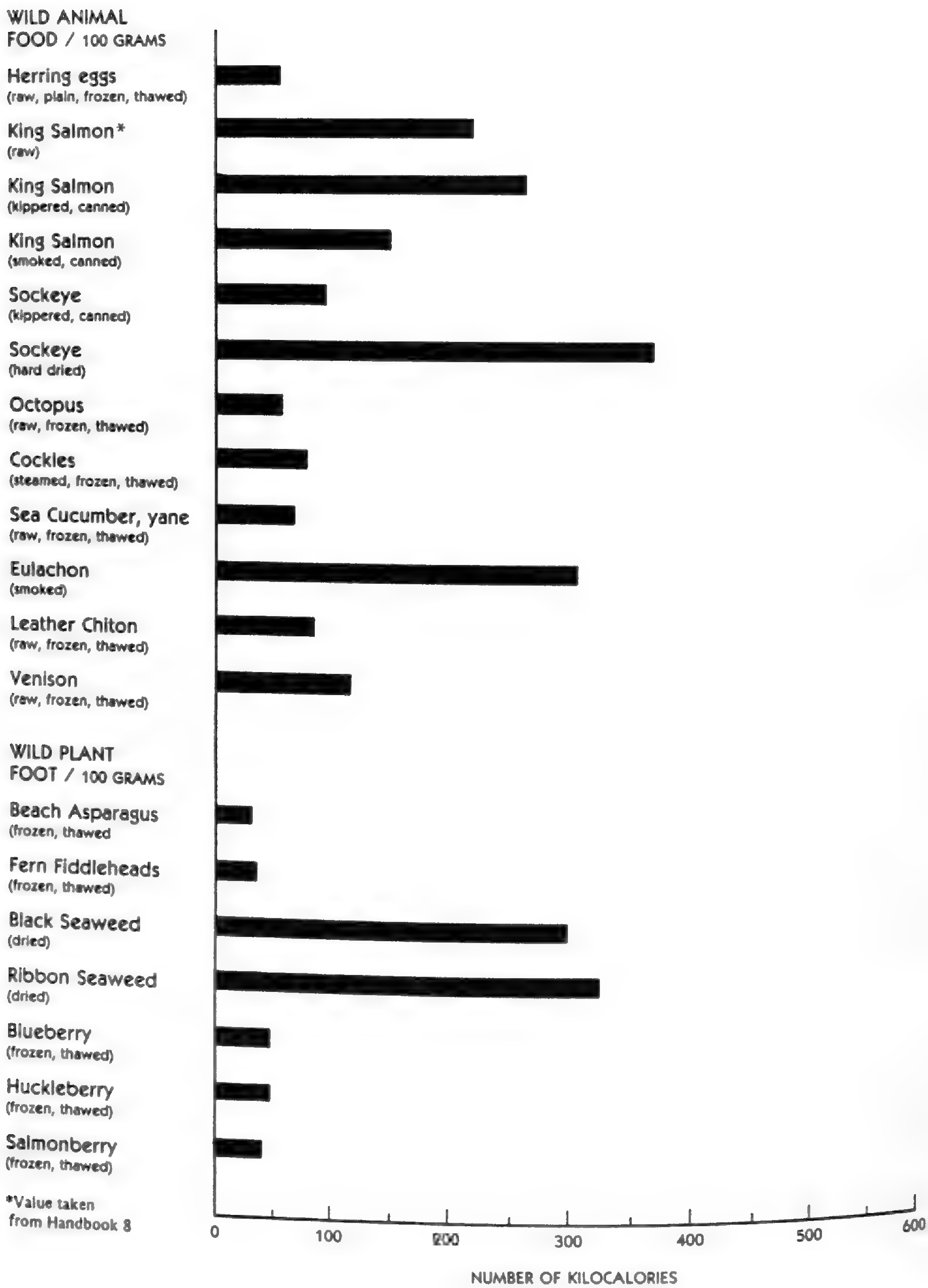


FIG. 1.—Caloric values for native animal and plant foods.

PLANT FOODS

Of the seven plant foods tested, the two dried seaweeds, black seaweed *(Porphyra* cf *laciniata)* and ribbon seaweed, *(Palmaria* sp.), were outstanding for their generally high nutrient content. A 100 g sample of each contained nearly one-half the adult Recommended Dietary Allowance (RDA) (Food and Nutrition Board 1980) for protein, almost one-quarter the requirement for calcium, all the male requirement for iron and over half the iron needed by a female. One hundred grams of black seaweed contained 100% of the RDA for riboflavin, over half the allowance for niacin and vitamin A, one-third the allowance for ascorbic acid. Japanese workers have made nutrient analyses on marine algae, but there is little American literature on their nutrient content. They are generally recognized as being excellent sources of many nutrients and some even contain vitamin B_{12} (Madlener 1977, Arasaki and Arasaki 1983). Thiamin content was low in both seaweeds (as well as in other foods).

One hundred grams of dried seaweed equals about 590 ml (2½ cups). Some Native informants reported that eating dried seaweed is "like eating popcorn" and that this amount could easily be eaten in a short period. Other Natives stated that they could not eat much because it "swelled up" and satisfied them quickly.

Beach asparagus *(Salicornia pacifica)* and fern fiddlehead *(Athyrium filix-femina)* had vitamin A values such that a 100 g portion would be adequate to meet one-fourth the adult RDA. Beach asparagus, also called glasswort, is steamed or eaten raw, but can be canned or frozen to be used later as the main ingredient of a salad. Fern fiddleheads may be added raw to salad or steamed and eaten as a vegetable.

Ascorbic acid values were tested for the three berries: blueberry *(Vaccinium alaskanese* and *V. ovalifolium)*, huckleberry *(Vaccinium parvifolium)* and salmonberry *(Robus spectabilis)*. Values were lower than anticipated, and were therefore analyzed for a second time using samples from the same (1980) time period. The two results were similar and were averaged. Subsequent analyses done in a different laboratory since this study, provided comparable values. Table 3 shows the results of each of these analyses. Handbook 8 values for fresh raw blueberries is 14 mg/100 g and 7 mg/100 g if frozen (Watt and Merrill 1963).

Low ascorbic acid values could have resulted from the seven-month storage period in the freezer before analysis. It should be noted that many people eat the berries after such a storage period, so that these values could represent actual intake. Another possible influence may have been the many cloudy, rainy days in southeastern Alaska. Studies have shown that ascorbic acid development in citrus fruit is sensitive to the amount of sunlight reaching the fruit during maturation (Nagy 1980). Conversely, Rodahl (1955) found that berries grown in drier Arctic areas had an increased ascorbic acid content probably due to the 24-hour days.

TABLE 3.—Vitamin C content of berries from two separate analyses.

Berry	1st Analysis	2nd Analysis
Blueberry	3.5 mg/100 gm	0.8 mg/100 gm
Huckleberry	2.1 mg/100 gm	3.4 mg/100 gm
Salmonberry	3.1 m/100 gm	1.6 mg/100 gm

ANIMAL FOODS

The four salmon samples varied considerably in caloric content, with the "hard-dried" sockeye being the most concentrated source of calories. King salmon is the salmon species with highest fat content according to figures from Handbook 8 (Watt and Merrill 1963). However, sockeye also contains a generous amount of fat which becomes more concentrated with dehydration, so that all values for his hard-dried sockeye sample are higher than for other salmon samples.

The salmon in these analyses contained significant amounts of calcium and iron. However, Handbook 8 values are considerably higher, possibly because of a significantly higher bone content. Calcium in canned salmon will vary with the amount of bone left in any one piece.

All salmon samples were good sources of niacin. A 100 g portion of the sample with the least, (smoked, canned king) met 50% of the adult RDA. Amounts ranged from 8.5 mg/100 g to 13.9/100 mg in the three samples which contained the lesser amounts. It should also be noted that since these samples were subjected to a significant period of high temperature during canning some loss of the B-complex vitamins may have occurred. Handbook 8 shows higher values for thiamin in both raw king and sockeye over canned and higher riboflavin values in raw king salmon. The sample with the highest value for niacin (hard-dried sockeye) contained more than 100% of the RDA with a content of 20.2 mg/100 g. Both samples of sockeye had higher values for riboflavin and niacin than king salmon. Thiamin values were low in all foods analyzed but hard-dried sockeye had better amounts than any others, again because of contentration. It is not understood why there was considerable variation in the vitamin A content of the salmon samples.

Plain herring eggs *(Clupea pallasii)* which had been removed from hemlock branches *(Tsuga heterophylla)* showed no outstanding nutrient content. Those eggs on kelp *(Macrocystis integrifolia)* had somewhat higher scores. Herring eggs are eaten plain or on the kelp on which they have been deposited and are always a special treat. When available they may be consumed in large quantities. They may be eaten raw or cooked by simmering in water briefly then dipped in seal or eulachon fat. Often they are frozen raw to be used later for special occasions.

Each spring, when water temperatures rise sufficiently to stimulate the herring to spawn, Native people will go to their favorite spots in bays and coves to collect the eggs. In locations where there is no kelp, hemlock branches may be placed on the beach at low tide and secured in place by string or with rocks. The herring deposit their eggs on the branches which, after several tidal changes, may have a sizeable concentration of eggs of up to 7 or 8 cm in thickness. Eggs are 1 mm to 2 mm in size and the production for one female may average about 20,000 eggs in a season.

Smoked eulachon *(Thaleichthys pacificus)*, leather chiton *(Katharina tunicata)* and cockles *(Clinocardium nuttallii)* all were excellent sources of iron. A 100 mg amount provides a minimum of two-thirds of the adult RDA for iron. Octopus *(Octopus dofleini)* also provided a significant amount. In northern Alaska nutritionists have been concerned about a high incidence of iron deficiency anemia among the Native population (Margolis et al. 1981). In southeastern Alaska this has not been reported to be a problem. This may be due, at least partially, to the ready availability of these foods. Cockles, which are similar to clams, are frequently found and used, along with clams, in great numbers on southeastern Alaska beaches.

Leather chiton was a good source of vitamin A. One hundred grams contained nearly one-fourth of the RDA for both riboflavin and niacin and more than one-eighth of the RDA of calcium. This nutritious member of the mollusk family, popularly called gumboots, is very well liked by southeastern Alaska Natives. Chiton can be gathered from the rocks of the rugged coastline during low tides. They are cooked briefly, below the boiling point of water, and are eaten either warm or cold, with or without seal oil or eulachon fat.

Sea cucumber *(Stichopus californicus)* was surpassed only by the two seaweeds for riboflavin content with 100 g providing over half the adult RDA. The favorite way to eat this is fried in butter or margarine after being dipped in egg and cracker crumbs.

Smoked eulachon, with its Vitamin A rich, high fat content, would more than meet a day's RDA for many adults for Vitamin A with a moderate portion of approximately 2-3 fish (100 g). As might be expected, the pure eulachon fat contained an even higher Vitamin A content than the whole fish. Kuhnlein (1982) noted the high content of her samples and the ease with which these Natives could meet their daily requirement.

The fatty acid analysis done on eulachon fat indicated a level of 32.5% saturated fatty acids and a 3.5% polyunsaturated fatty acid (PUFA) content. Monounsaturates comprised the largest amounts: oleic (18:1), 55% and palmitoleic (16.1), 5.5% (Fig. 2). Kuhnlein et al. (1982) reports comparable figures for fatty acid content of eulachon fat. She found that oleic fatty acid was the primary fatty acid with a mean content of 54.6%. The second most prominent was the saturated fat, palmitic (16:0), with a mean content of about 18%. This analysis showed a content of 20.5% for palmitic acid. Kuhnlein et al. found the overall total unsaturated fat content to be 65% while these results showed a close 64%.

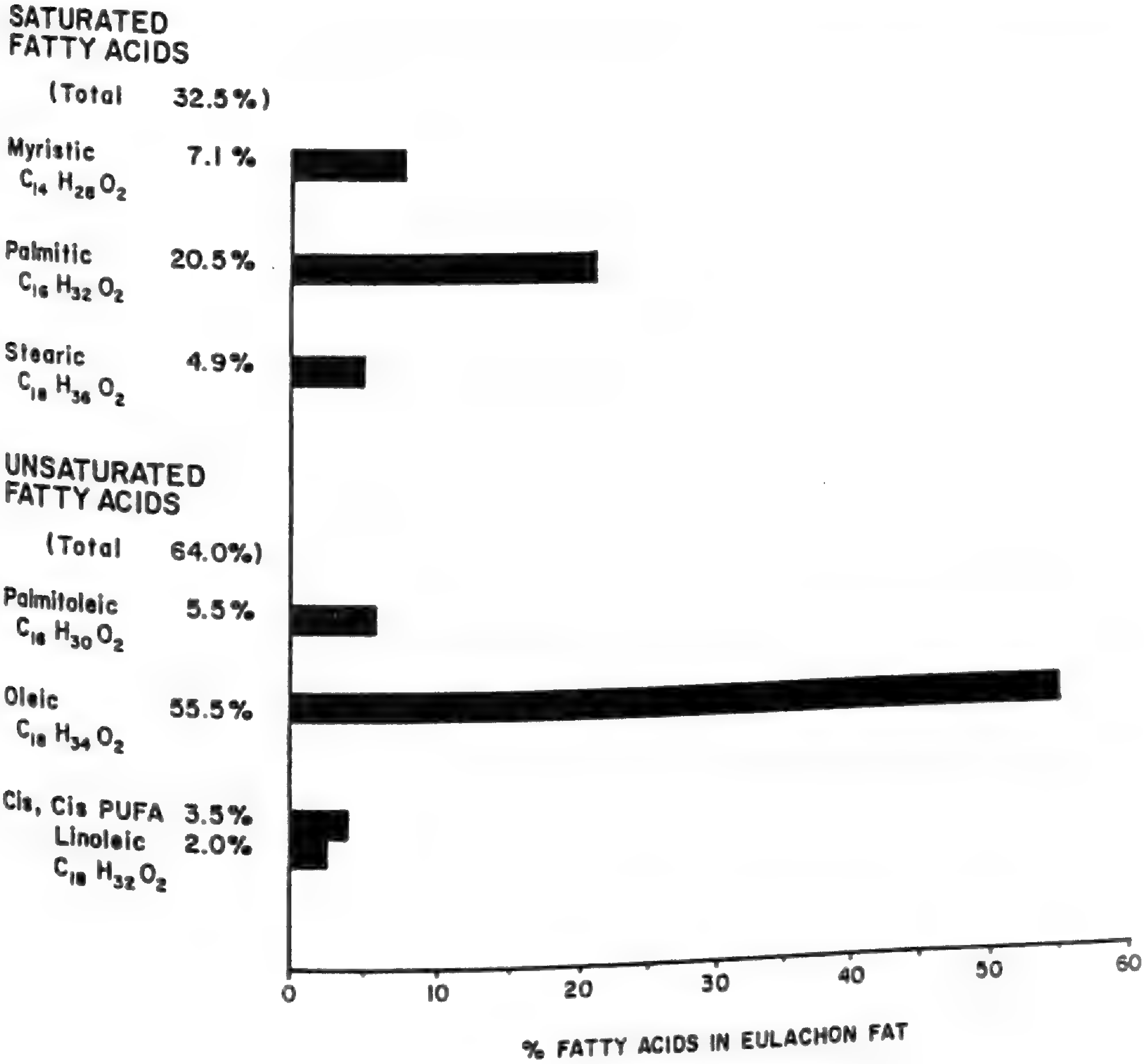


FIG. 2.—Fatty acid content of eulachon fat.

Fish and marine mammals have attracted wide interest recently because many contain fatty acids with long carbon chains of up to five and six double bonds and the Ω-3 configuration. Eicosapentaenoic acid in particular has been cited (Dyerberg et al. 1975, Harris and Conner 1980, Bronsgeest-Schoute et al. 1981).

In this analysis, an AOAC procedure primarily intended to measure degree of unsaturation was used. The procedure provided quantitation for linoleic acid which amounted to 2%. The remaining 1.5% (of the total 3.5% PUFA) was not identified and could possibly have included some eicosapentaenoic acid. Here again Kuhnlein et al. (1982) results were very similar. In this report total percentage of all fatty acids does not equal 100%. At the time of these analyses, little information on fatty acid content of many marine species was available and no standard had been developed for eulachon fat. For this reason laboratory procedures were not prepared to determine the possible presence of odd numbered, long-chain fatty acids. It is possible there may have been some. Also, there may have been unusually long-chain fatty acids present which would not have shown up on the gas chromatogram in the anticipated time period (Fig. 2).

The venison *(Odocoileus hemionus sitkensis)* sample was provided by a hunter from Hydaburg who said it contained more fat than most venison he had seen. However, when one compares the 3.4 g per 100 g of ground venison with the Handbook 8 value of 10.0 g per 100 g for lean ground beef one can see that the fat content of venison is significantly lower.

Because the food samples for these anlyses were collected from a number of different sources, and with the exception of berries, testing was limited to one sample, the data probably should not be used for specific comparisons. However, there is a dearth of nutrient information on foods indigenous to southeastern Alaska and these results do provide basic information which has been urgently needed. If these data are used on a provisional basis until further clarification is available, this study will be of value to those who use these foods.

SUMMARY AND CONCLUSIONS

This nutrient analysis of twenty wild foods eaten by Native peoples of southeastern Alaska provided information which has not previously been available. With the exception of ascorbic acid and thiamin, all nutrients were present in generous amounts. Since a number of local wild foods remain untested, it is possible that these two nutrients could be available from other sources.

With the prospect of increased nutritional information about foods of the area and the great local interest, every possible measure should be taken to ensure their environmental protection. At the same time, it seems appropriate to encourage their continued use by Native people.

ACKNOWLEDGEMENTS

1. This research was funded by the Alaska Department of Health and social Services Holistic Health Project through a grant to the Southeast Alaska Region Health Corporation and approved by the Indian Health Service whose staff conducted the work.
2. The author wishes to thank the members of the Tlingit, Haida and Tsimsphean communities who provided foods, information and hospitality during the progress of this project. Grateful appreciation is expressed to the Columbia Laboratories staff for their continual cooperation; to Mary Muller, U.S. Forest Service Botanist, Sitka, who provided valuable discussion and assistance with botanical information; to others who assisted in the scientific identification and nomenclature: Natasha Calvin, National Marine Fisheries, Auke Bay Lab, Junaeu; Jill Thayer,

Cooperative Extension Agent, Sitka; Brad Sele, Area Biologist, Division of FRED, Alaska Department of Fish and Game, Sitka; Mel Seifert, Director, Aquaculture Program, Sheldon Jackson College, and Raymond RaLonde, Instructor, Fisheries and Biology, Sheldon Jackson College, Sitka. The support, guidance and direction provided throughout the project by Dr. Lee Schmidt, Director, Community Health Services, Mt. Edgecumbe Native Hospital, was invaluable.

LITERATURE CITED

ARASAKI, S. and T. ARASAKI. 1983. Vegeables from the Sea. Japan Publications, Inc. Tokyo, p. 44.

BENSON, E.M., J.M. PETERS, M.A. EDWARDS, and L.A. HOGAN. 1973. Wild edible plants of the Pacific Northwest. J. Am. Dietet. A. 62:143-146.

BRONSGEEST-SCHOUTE, H.C., C.M. VANGENT, J.B. LUTEN and A. TUITER. 1981. The effects of various intakes of Ω-3 fatty acids on the blood lipid composition in healthy human subjects. Am J. Clin. Nutr. 34:1752-1757.

DRUCKER, P. 1955. Indians of the Northwest Coast. The Natural History Press, New York.

DYERBERG, J., H.O. BANG and N. HIORNE. 1975. Fatty acid composition of the plasma lipids in Greenland Eskimos. Am. J. Clin. Nutr. 28:958-966.

FOOD AND NUTRITION BOARD. 1980. Recommended Dietary Allowances. 9th Ed. National Res. Council, National Acad. Sci. Washington, D.C.

HARRIS, W.S. and W.E. CONNER. 1980. The effects of salmon oil upon plasma lipids, lipoproteins, and triglyceride clearance. Transactions of the Association of American Physicians. xciii:148ff.

HELLER, C.A. 1964. The diet of some Alaskan Eskimos and Indians. J. Am. Dietet. A. 45:425-428.

HELLER, C.A. and E.M. SCOTT. 1967. The Alaska Dietary Survey, 1956-1961. The U.S. Department of Health, Education and Welfare, P.H.S., Washington, D.C.

HOROWITZ, W., Ed. 1975. Official Methods of Analysis, 12th ed., Assoc. Off. Anal. Chemists, Washington, D.C.

HOROWITZ, W., Ed. 1980. Official Methods of Analysis, 13th ed., Assoc. Off. Anal. Chemists, Washington, D.C.

KUHNLEIN, H.V., D.H. CALLOWAY and B.F. HARLAND. 1979. Composition of traditional Hopi foods. J. Am. Dietet. A. 75:37-41.

KUHNLEIN, H.V., A.C. CHAN, J.N. THOMPSON and S. NAKAI. 1982. Ooligan grease: a nutritious fat used by native people of coastal British Columbia. J. Ethnobiol. 2:154-161.

MADLENER, J.C. 1977. The Sea Vegetable Book. Clarkson N. Potter, Inc., New York.

MARGOLIS, H.S., H.H. HARDISON, T.R. BENDER and P.R. DALLMAN. 1981. Iron deficiency in children: The relationship between pretreatment laboratory tests and subsequent hemoglobin to iron therapy. Am. J. Clin. Nutr. 34: 2158-2168.

NAGY, S. 1980. Vitamin C Contents of Citrus Fruit and Their Products: A Review. J. Agric. Food Chem. 28:8ff.

PIKE, R. and M. BROWN. 1975. Nutrition: An Integrated Approach. John Wiley and Sons, New York.

PRICE, W.A. 1939. Nutrition and Physical Degeneration. Paul B. Hoeber, Inc.: Medical Book Department of Harper and Brothers, New York.

RODAHL, K. 1955. Vitamin Content of Arctic Plants, Part III. Trans. Bot. Soc. Edin., Vol. XXXVI, P. IV.

SCHAEFER, O. 1971. When the Eskimo comes to town. Nutrition Today 6:8ff.

SIDWELL, V.D., P.R. FONCANNON, N.S. MOORE and J.C. BONNET. 1974. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. I. Protein, fat, moisture, ash, carbohydrate, energy value, and cholesterol. Marine Fisheries Review 36:21-35.

SIDWELL, V.D., D.H. BUZZELL, P.R. FONCANNON and A.L. SMITH. 1977. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. II. Macroelements: sodium, potassium, chlorine, calcium, phosphorus and magnesium. Marine Fisheries Review 39:1-11.

LITERATURE CITED (continued)

SIDWELL, V.D., A.L. LOOMIS, R.P. FONCANNON and D.H. BUZZELL. 1978. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish and mollusks. IV. Vitamins. Marine Fisheries Review 40:1-16.

SIDWELL, V.D., A.L. LOOMIS, K.J. LOOMIS, P.R. FONCANNON and D.H. BUZZELL. 1978. Composition of the edible portion of raw (fresh or frozen) crustaceans, finfish, and mollusks. III. Microelements. Marine Fisheries Review 40:1-20.

TURNER, J.J. 1975. Food Plants of British Columbia Indians. Part 1. Coastal Peoples. British Columbia Provincal Museum.

UNDERHILL, R. 1945. Indians of the Pacific Northwest. United States Department of the Interior: Bureau of Indian Affairs, Washington, D.C.

WATT, B.K. and A.L. MERRILL. 1983. Composition of Foods—Raw, Processed, Prepared. Rev. USDA Agriculture Handbook No. 8, Washington, D.C.

NOTE

1. Current address: 1011 Halibut Point Road, Sitka, Alaska 99835.

J. Ethnobiol. 5(2):101-107 Winter 1985

THE ETHNOPHARMACOLOGY OF *CENTELLA ASIATICA* (L.) URBAN (APIACEAE)

WILLIAM A. EMBODEN
Professor of Biology
California State University, Northridge
Northridge, CA 91330

ABSTRACT.—*Centella asiatica* is a creeping, prostrate, perennial herb of both the Old World and the New World tropics. It is marketed as a medicinal herb in China, Java, India, Madagascar, Sri Lanka and recently in the United States. The oldest traditions surrounding this herb derive from the earliest Chinese pharmacopoeias and associate it with the qualities of restorative, detoxification prolongation of life and a general energizer. These qualities as well as other attributes are common to the belief systems of other regions where the herb is used. An analysis is presented in which the known chemistry and pharmacology is related to efficacy of both herbal preparations and chemical isolates. The implications of *in vivo* and *in vitro* assays are discussed. Much of the ancient and contemporary lore surrounding this plant is justified on the basis of experimental evidence. When consumed in large amounts it has been found to cause vertigo, act as a narcotic and induce comatose states.

Several plant species and genera have been confused with *Centella asaiatica* (L.) Urban. The reasons are twofold: Chinese characters have been variously deciphered and transliterated into Roman text and these derive from diverse provinces where the genus has been used. Secondly botanists have attempted to use Chinese transliterations to elucidate the plant in question and have implicated *Conocephalus, Nepeta* and *Hydrocotyle*. Beyond the issues of correct botanical nomenclature, marketing of *Centella asiatica* under a variety of names that are registered or indicated as a trademark introduces further complications. Some suppliers of herbal pharmaceuticals have used corruptions of a Chinese name for *Centella asiatica* to introduce a combination of plant products. The Chinese ***Fo-ti-ts'ien*** which translates as "ground coin" is often presented as ***Fo-ti-tieng*** which, according to Dr. Charles Tseng (pers. comm.), translates as "that which creeps" implicating any number of prostrate herbs.

One of the earliest encounters with *Centella asiatica*, found under the entry ***Chi-hsueh-ts'ao,*** is the *Pen Ts'ao* of the Chinese herbalist Li Shih-Chen dating to 1578. The volume reportedly involved twenty-six years of scholarly investigation and as much pragmatic experimentation. In addition, it relied heavily upon an oral tradition extending to the Emperor Shen-Nung who lived around 2737 B.C., long before the appearance of a written language in China. Li Shih-Chen's publication did not appear in English until the recent translation and additional research added by Stuart and Porter-Smith (1973). These investigators included their own observations and annotations to the herbal remedies already included in this giant compendium. Commercial sources of "registered ***Fo-ti-tieng***" often contain additives such as kola nut *(Cola nitida* or *Cola acuminata)* and meadowsweet. *Centella asiatica* is also marketed in the United States under the trade name *Gotu Kola* and the ingredient is indicated as *Hydrocotyle asiatica*. *Hydrocotyle* is a different genus in the family Apiaceae and it has an upright habit.

Some other synonyms in China are: ***P'o't'ung-chien*** "broken copper coin" and ***Kang-kuo lung,*** for which I have no translation. These are but a few names from the diverse areas of one country where the herb has found considerable popularity.

There is every reason to be suspicious of many of the eight thousand prescriptions that appear in the *Pen Ts 'ao*; on the other hand, we have reason to be cautious in approaching the ever proliferating number of prescription and patent medicines that flood our drug stores and supermarkets. Many of these are the same materials sold under a variety of names. When apreparation is of herbal origin, it is unlikely that the buyer will be able to find an indication of the genera and species involved. A case in point is a popular laxative (one of America's favorite medicants) that is composed of the seed husk of *Plantago psyllium* that absorbs water, swells and releases mucilage. This simple herbal seed husk is sold under a great number of patented names and without generic or specific identification.

There is clarification needed with regard to the entry ***Chi-hsueh-ts'ao*** in the ***Pen-ts'ao.*** While this entry in a reference to *Centella asiatica*, there is also a discussion in the same place of ***ti-ch'ien-ts'ao,*** which is the mint *Nepeta glechoma*. A misunderstanding of Bretschneider (1850) led to the subsequent popular belief that ***Chi-hsueh-ts'ao*** *(Centella asiatica)* was *Nepeta Glechoma* which has no significant pharmacological action. As a result, the herb *Centella asiatica* was ignored in the West for a considerable period of time, and a serious consideration of it did not appear until the studies of Bontemps (1942). In the interim it remained a popular folk remedy in China, Ceylon, Java, India and elsewhere. As such, the entire leafy structure of the plant was eaten or an extract of the plant juices was used both externally for dermatitis, wounds and sores, and internally for a number of specific and non-specific diseases. Most commonly it was thought to be a cure for leprosy, tuberculosis, mental retardation and general debilitation of health (Table 1).

Centella asiatica is so inconspicuous that it is scarcely noticed unless searched out. It creeps along the ground by means of numerous stolons that establish new plants in moist soil adjacent to the progenitor forming dense mats in marshy or boggy areas. Copious stands are found in tropical areas of India, Ceylon, and parts of China. It seems to have few natural predators (excepting mealy bug) and requires no real cultivation. The leaves, about the size of a quarter when well grown, are covered with a combination of glandular and sterile hairs. The flowers are barely visible to the naked eye as are the two-parted fruits (schizocarps) that follow. The fruits are traversed with oil tubes that carry an oil with fragrance characteristic of the leaf oils. Being a member of the family *Apiaceae* (formerly *Umbelliferae)* it is related to parsley, celery, carrots and dill.

In China it was historically known as "snow plant" for reason of its cooling properties. It is also classified in Western herbal medicine as a refrigerant, that is to say a botanical agent that has cooling effects and may be used to allay fevers. More importantly the Chinese regarded the plant *Centella asiatiaca* (also known under ***Chi-hsueh-t-ao***) as able to prevent both disease and senescence.

The term "adaptogen" is coming into prominence in the terminology of eastern Europe and especially the Soviet Union and Asia. An adaptogen (Brekhman and Daroymov, 1969) is a naturally derived compound or plant that is non-toxic, has the ability to increase resistance to stress, and is effective against some bacterial agents, viruses and toxins. Adaptogens have a normalizing effect by stabilizing blood pressure and endocrine imbalance. The question put before us is this: Is *Centella asiatica* an adaptogen? If so, what actual chemical properties does it exhibit, and what diseases is it effective against?

According to Leyel (1970) the Chinese referred to *Centella asiatica* as "elixir of life". She lists the constituents as "vellarine, having the odor and bitter persistent taste of the fresh plant, resin, some fatty aromatic body, gum, sugar, albuminous matter, salts, mostly alkaline sulphates and tannin." She indicates the action to be that of an alternative (changing a morbid state of being into one of health), diuretic and tonic. Collectively these suggest an adaptogen or in her terms, elixir of life. It is unfortunate that she does not provide bibliographic references, for her suggestions regarding the plant as a tonic and as a narcotic in large doses are most intriguing. Accounts of longevity and virility are derived from Leyel's treatment of the herb. She asserts that the Chinese herbalist Chang-li-yun lived to the age of 256 years and married 24 times, attributing this to his having drunk an infusion of *Centella* every day. Likewise the Indian sage, Nanddo Narian, is alleged by Leyel to have lived to the age of 107, using the plant to ward of disease.

Leyel's account of Professor Menier of Paris discovering in the leaves an energizing property which influences the brain, as well as vitamin G, operative on the endocrine system, is most intriguing. It corresponds to the work of Jules Lepine, a biochemist who had previously described these properties from his studies of the plant.

By 1933 the French government had established an agricultural and medical experimental station in Algeria to study this herb. The English founded the Ayurvedic College of Research in Colombo, Ceylon where similar studies have been conducted. Leyel states that Dr. Menier of the Academie Scientifique in Paris reported vitamins G and X as stimulators of the endocrine system (without any specific structural formulas presented), and as detoxifiers of the body and stimulants of the central nervous system. All are alleged to generally enhance metabolism.

Oliver-Bever (1983) has classified *Centella asiatica* as a plant having a stimulant action on the autonomic nervous system. He notes also that the leaves and stems in infusion have been used in India for the treatment of leprosy and other dermal diseases (as recorded in the *Indian Pharmaceutical codex.)*, while larger doses are said to have a narcotic effect.

Reports on the effects of *Centella* as a tonic or stimulant differ with habitat. This can be attributed to saponin content which is variable and is habitat dependent. The most common condition is to find asiaticoside and medacanoside present. When arabinose is present in the saponins, a less usual condition, brahmoside and brahminoside (triglycoside and tetraglycoside of brahmic acid) are formed (Appa Rao et al., 1969). These workers also found betulic acid and stigmasterol in the arabinose-containing variants. Apart from habitat dependent variation there would appear to be genetically based variation accounting for the consistency of reports within, but not between, continents.

Asiaticoside (a genin glycoside of a pentacyclic triterpenic acid) was isolated from plants of Madagascar by Bontemps (1942), but was not able to be extracted from Ceylonese plants (Bhattacharya and Lythgoe, 1949). However, the plants from Ceylon contained the related compound centelloside as well as centoic acid and centellic acid. This was subsequently confirmed by Boiteau et al., 1949, 1956, and by Oliver-Bever, 1960. Dutta and Basu (1967) identified asiatic acid, asiaticoside, mesoinosital and an oligosaccharide of centellose. Rao and Seshadri (1969) confirmed that sapogenins and flavonoids were in both the arabinose containing a variety of *Centella* and those without arabinose.

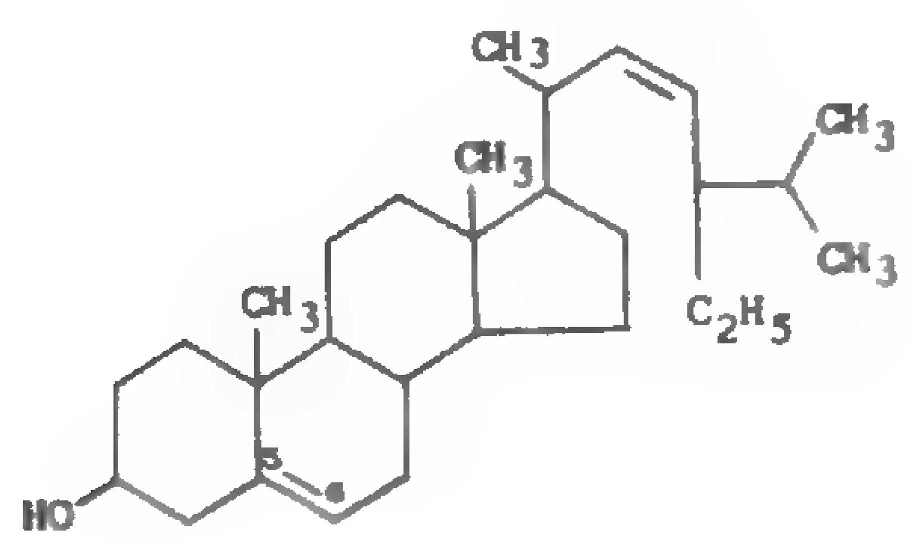
The presence of asiaticoside is significant in that it has been found to dissolve the wax capsule of *Mycobacterium leprae*, the causal agent of leprosy. Further, when asiaticoside is oxidized to oxyasiaticoside, which takes place *in vivo*, tubercle bacilli are inhibited (Boiteau et al., 1949). Studies by Appa Rao et al. (1969, 1973) on 30 mentally retarded children free from neurological disfunctions, and 43 "presumed normal" adults revealed significantly improved ability and behavior among the children after feeding the whole plant as a dietary supplement for 12 weeks. In the adult "control group" there was an increase in mean levels of serum cholesterol, blood sugar, and total protein. Among these same adults, there was a decrease in mean levels of blood urea, serum acid and phosphatase. The suggestion (not advanced by these researchers) is that this plant may be especially useful in cases of gout and perhaps in some kinds of diabetes. Reports on narcoses from the ingestion of large amounts of *Centella asiatica* are sporadic and are in need of substantiation via controlled experimentation.

Rock (1920) believed the plant to be poisonous and suggested that it not be eaten, at least not those growing in the Hawaiian Islands where it is known as "wild swamp violet" for reasons unknown. The allegations that it causes gastritis and dermal irritation seem to be unfounded as regards the the general populace.

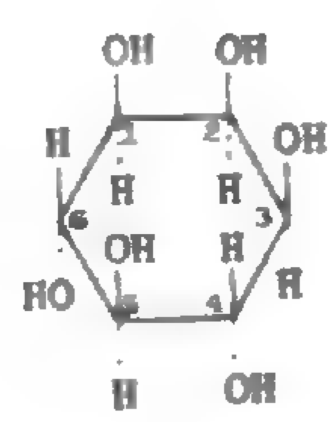
Arnold (1968) in writing on *Poisonous Plants of Hawaii* suggests that Rock is incorrect in his assertions of "dangerously poisonous." Arnold cites de Grand Pre (1888) in suggesting the plant is a stimulant and energetic (sic) in small doses, but produces vertigo and a tendency to coma in large doses. He concludes, " . . . It is obviously not especially dangerous."

Stigmasterol is an interesting isolate in that it is usually obtained from *Glycine maximum* (soy bean) or *Physostigma venemosum* as starting materials for hormone synthesis. Most hormones obtained in a pure state and on a large scale must be synthesized by combining chemical and microbiological processes. Starting with a preformed steroidal nucleus is far more feasible than any attempt at total synthesis.

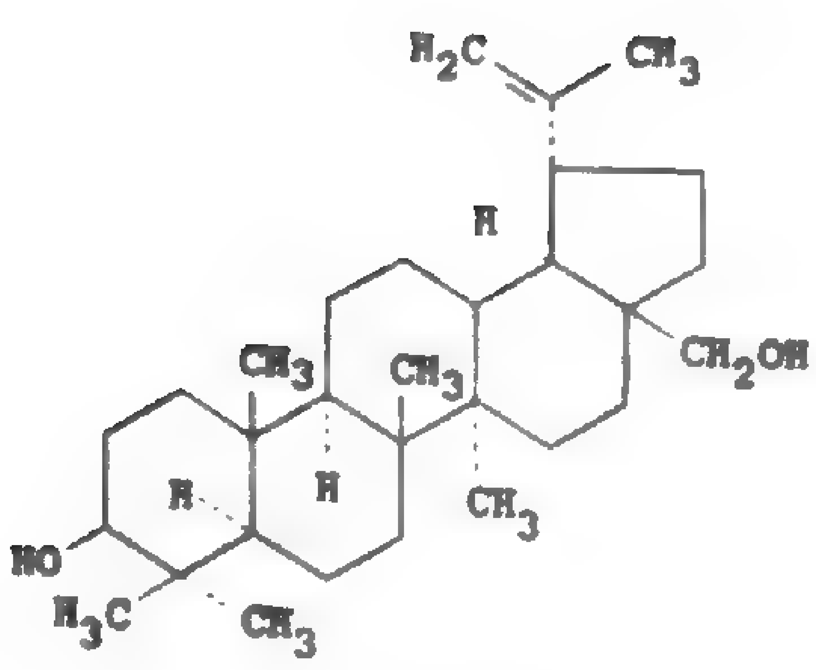
The finding of mesoinosital (Inositol) by Dutta and Basu (1967) is intriguing. This hydroxycyclohexane is widely distributed in both plants and animals and is a growth factor for animals and for microorganisms. As such some have considered it a vitamin and at least two patents exist covering it. The chemical is classified also as a lipotrophic agent enhancing fat metabolism (Sebrell-Harris, 1954). The previously mentioned compounds are summarized in Fig. 1.



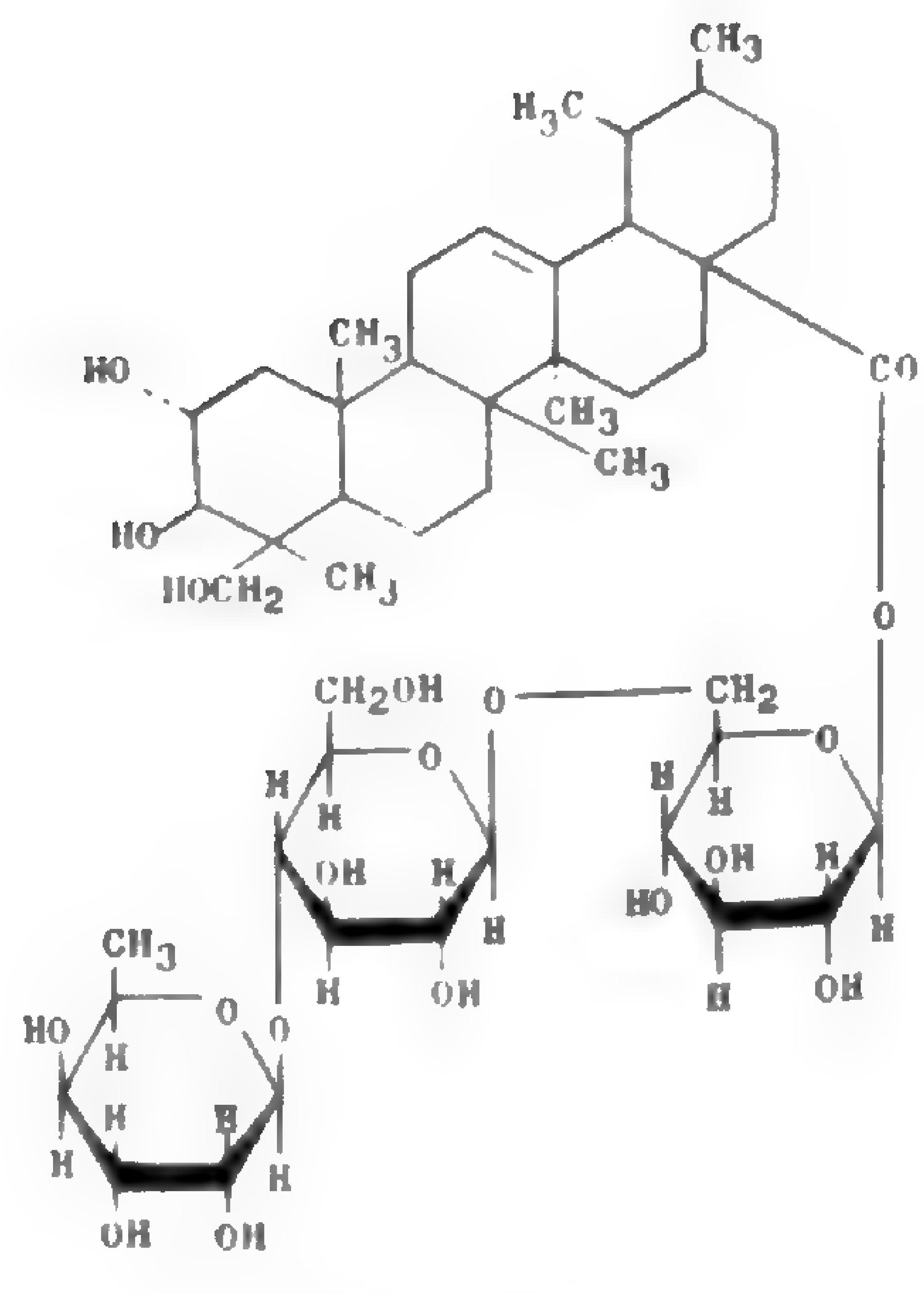
Stigmasterol.



Inositol.



Betulin.



Asiaticoside.

FIG. 1.—Structural formulae of four compounds isolated from *Centella asiatica*.

Dwayne Ogzewalla, Professor of Pharmacognosy at the University of Cincinnati and his student Prakongsiri Boonkong (pers. comm. 1984) have convincing data that skin damage from podophyllin *(Podophyllum peltatum* resin) is ameliorated and healed by applications of *Centella* in a neutral cream base as a carrier. The same did not hold true when the *Centella* cream was applied to lesions caused by *Toxicodendron*. Mice fed for three months with 10% dry weight of *Centella* added to their diet showed no difference in weight or activity from the control group. This study continues and was at the time of communication hampered by the inability of the researchers to get relatively pure asiaticoside or asiatic acid.

TABLE 1.—*Centella: Crude plant material.*

Region of Derivation	Author-Researcher	Utilization or Properties
India, Ceylon & Madagascar	Indian Pharmaceutical Codex	Leprosy Diuretic Narcotic
India, Ceylon, Madagascar & Tropical West Africa	Oliver-Bever, 1983	ANS Stimulant Bitter Tonic Analeptic
India	Jain, 1981	
Khasi & Jaintia		Dysentery Boils Tumors
Orissa		Cough Syrup Dysentery
China	(Fide Leyel, 1970) Chang-li-yun Narian Menier	Diuretic Tonic/Narcotic Alternative "Adaptogen" "Adaptogen" Endocrine Tonic Vitamins G and X Detoxification
India	Appa Rao et al., 1973	Rehabilitation of Mental Retardation in Children: Decrease in blood urea, serum acid and phosphatase
Hawaii	De Grand Pre, 1888	Stimulant, Nerve Tonic Energetic

In summation it may be stated that *Centella asiatica* is a plant with potential in medicine. It has been ignored in the United States and is seldom seen in cultivation. As the uses outlined in Tables 1 and 2 suggest, there are a number of known diseases for which it may be a remedy or cure and in addition it may serve as an adaptogen allaying stress and retarding or eliminating the development of diseased states.

TABLE 2.—*Effects of isolates of Centella Asiatica (L.) Urb.*

Regional Source	Researcher(s)	Isolate(s)	Uses
Madagascar	Bontemps, 1942	Asiaticoside (Madecassol)	Anti-Leprosy Drug *(Mycobacterium leprae* capsule dissolved)
Madagascar	Boiteau et al., 1949	Oxyasiaticoside	Tubercule Bacilli Inhibited *in vivo*
Sri Lanka (Ceylon)	Bhattacharya & Lythgoe, 1949	Centelloside Centoic acid Centellic acid (Asiaticoside absent)	Not indicated, but Centelloside is related to Asiaticoside
India	Appa Rao et al., 1969	Arabinose Brahmic acid Brahmoside Brahminoside Isobrahmic acid Betulic acid Stigmasterol	Ascites and Rheumatism Hormonal Nucleus
India	Dutta and Basu, 1967	Asiatic acid Asiaticoside Centellose Medacanoside Mesoinosital (Inosital)	Growth Factor Lipotrophic Agent
India	Rao and Seshadri, 1969	Flavonoids Sapogenins	Chemical Confirmation: Presence of these in all chemical variants

LITERATURE CITED

APPA RAO, M.V.R., S.A. RAJAGOPALAN, V.R. SRINAVASAN, and R. SARANGAN. 1969. Study of Mandookaparni *(Centella asiatica)* for the anabolic effect on normal healthy adults. Nagarjun, 12:33.

APPA RAO, M.V.R., J. SRINIVASAN, and K.T. RAO. 1973. The effect of *Centella asiatica* on the general mental ability of mentally retarded children. J. Res. Indian Medicine. 8-12.

ARNOLD, H.L. 1968. Poisonous Plants of Hawaii. C.E. Tuttle Co., Rutland, VT.

BHATTACHARYA, S.K., and B. LYTHGOE. 1949. Derivations of *Centella asiatica* used against leprosy. Triterpenic Acids. Nature, 163:258-259.

BOITEAU, P., M. DUREUIL, and R.R. RATSIMAMANGA. 1949. Contribution a l'etude des proprietes antituberculeuses de l'oxyasiaticoside de *Centella asiatica*. Comptes Rendus de l'Academie des Sciences, Paris, Serie D, 228: 1165-1167.

BOITEAU, P., and A.R. RATISMAMANGA. 1956. Asiaticoside isole de *Centella asiatica* et ses emplois therapeutiques. Therapie, 11:125-150.

BONTEMPS, J. 1942. Gazette Medicale Madagascariensis, 5:29.

BREKHMAN, I.I. and I.V. DAROYMOV. 1969. New substances of plant origin which increase non-specific resistance. Ann. Rev. Pharmacology, 9:419-430.

BRETSCHNEIDER, E. 1850. On the Study and Value of Chinese Botanical Works, With Notes on the History of Plants and Geographical Botany From Chinese Sources. Foochow.

DE GRAND PRES, C.C. 1888. Nouvr. Rem. April 8, no pagination.

DUTTA, T. and D.K. BASU. 1967. Terepenoids IV. Isolation and identification of asiatic acid from *Centella asiatica* L. Indian J. Chem., 5:586.

HU, S. 1980. An Enumeration of Chinese Materia Medica. Chinese Univ. Press, Hong Kong.

JAIN, S.K. 1981. Glimpses of Indian Ethnobotany. Oxford and I.B.H. Publ. Co., New Delhi.

LEYEL, C.F. 1970. Elixirs of Life. Samuel Weiser, Inc., New York.

OLIVER-BEVER, B. 1960. Medicinal plants in Nigeria. Nigerian College of Arts, Science and Technology.

OLIVER-BEVER, B. 1983. Medicinal plants in Tropical West Africa, II. Plants Acting on the Nervous System. J. Ethnopharmacology. 7:45-46.

RAO, P.S. and SESHADRI, R.R. 1969. Variations in the Chemical Composition of Indian Samples of *Centella asiatica*. Current Science. 38, 77-79.

ROCK, J.F. 1920. Hawaiian Forester and Agriculturalist, March, 60.

SEBRELL-HARRIS, M. 1954. Pp. 321-386 *in* The Vitamins, II. Academic Press, New York.

STUART, C.A. and F. PORTER-SMITH. 1973. Chinese Medicinal Herbs. (a translation with annotations of the *Pen Ts'ao* of Li-Shih-Chen, 1578).

SAVANNA WOODLAND, FIRE, PROTEIN AND SILK IN HIGHLAND MADAGASCAR

DANIEL W. GADE
Department of Geography
University of Vermont
Burlington, VT 05405

ABSTRACT.—Anthropogenic fire above 900 m elevation on Madagascar has created several discrete zones of savanna woodland dominated by tapia *(Uapaca bojeri)*. This tree, preadapted to surviving periodic burning, provides edible fruit, firewood and medicinal bark, but it is most important as a host plant to several useful lepidopteran insects. *Borocera madagascariensis* has been a source of silk made from its wild cocoons in tapia groves. Use of this fabric, still made on hand looms, is largely confined to shrouds for the elaborate reburial ceremony of the Merina and Betsileo ethnic groups. In addition, the pupae of *Borocera* and *Tagoropsis* are gathered and eaten by rural folk. Caterpillars that live on tapia leaves belonging to three different genera are also consumed, and the adult male of still another species is avidly sought for sale to butterfly collectors. A major shift in burning practice, fuelwood demand, mortuary ritual, or dietary custom could spell the end of this man/plant/animal symbiosis.

INTRODUCTION

On almost every continent and climatic zone, fires set by man have destroyed some plant communities while creating others. Periodic burning is now accepted as necessary to sustain certain ecosystems, and the only debate is how many of the fires were caused by lightning and how many by human agency. These "pyrophytic deformations" as Carl Sauer (1956:55) once called them, go far back enough in time to be viewed as part of the natural order. It is in the tropics that the cultural ecology of fire is the most pervasive and complex, but also the least understood and controlled (Bartlett, 1956:692-720). Anthropogenic burning of the various types of tropical forest has affected in both positive and negative ways the livelihoods of millions of traditional folk.

In few other places has fire disturbance had more far-reaching consequences than on the island of Madagascar in the Western Indian Ocean. Some 1,500 years of human settlement on this "isle of fire" have greatly modified its primeval vegetation. The early inhabitants, who came from Southeast Asia probably by way of the East African coast, were confronted with a Texas-sized territory whose original plant cover has usually been described as an evergreen forest of endemic species. Future research may modify this generalization, but what seems clear is that human modification has greatly changed the original vegetation. The highland interior, where half of the Malagasy population now lives, is the most transformed part of the island. Burning, and to a lesser degree cutting and overgrazing have removed all but tiny remnants of the native forest cover on the plateau. Slash and burn agriculture has long been superseded by paddy rice cultivation in the valley bottoms. It is the grass-covered hills that people still regularly burn to permit tender green shoots to replace the unpalatable withered culms in the dry season before onset of the rains. Land may also be torched at any time to eliminate grass and shrub species which are not palatable to cattle. In addition, incendiarism of the land rages over Madagascar as a way of expressing political or social discontent. For whatever cause, anthropogenic fire, favored by the ready combustibility of a long dry season, has created vast expanses of grass or tree savanna. The original highland forest of rich endemic diversity has not regenerated even in areas no longer burned. As on many other islands, evolution of the flora in isolation did not adapt native species to successfully cope with outside disturbances. The human ecology of Madagascar is attuned to the cultural inevitability of periodic fire, a process that highlights the futility of classifying phenomena attributable to culture from those considered to be "natural."

THE FIRE-DEPENDENT WOODLAND

In many places only one tree species, tapia *(Uapaca bojeri)* comprises this savanna woodland. Tapia is in the family Uapacaceae which includes only one genus, *Uapaca,* comprised of 62 species, 50 of them in Africa and 12 in Madagascar. Before human intervention, tapia was but one among many arborescent species that comprised the highland vegetation. Its heliophily suggests an ecological position in open habitats in the otherwise dense forest created by natural disturbances. Unlike most other forest components, tapia was able to survive burning and even thrive in the much reduced competition of its new habitat. Its thick, deeply fissured bark shields the cambium from fire, and a woody endocarp inside a fleshy drupe offers double protection to the seeds within. Vegetative reproduction is at least as important as seed germination. Suckers from underground meristems or stumps can develop into trees, an origin betrayed by multiple twisted trunks.

Low species diversity is another indication that savanna woodlands are an ecological response to periodic fire. Tapia is often the sole tree, although such stands are less homogeneous in areas with negligible human population (Fig. 1). Other tree species if present tend to mimic tapia in structural adaptation as a result of burning that has eliminated those that are fire-intolerant. These occasional cohorts include *Sarcolaena oblongifolia, Cussonia bojeri, Leptolaena bojeriana* and *Asteropeia densiflora* (Koechlin et al., 1974). Uniformity of size is also characteristic: the vast majority of tapia trees are from 8 to 10 m high with a diameter of 20-40 cm. Tapia cannot regenerate in its own dense shade, yet small saplings are rare even on the sunny margins where competition for light is less. Such an even-age pattern reflects burn periodicity. Ground fires systematically kill the tapia seedlings and sprouts, a suppression that results in the eventual eclipse of tapia groves as the old individuals die off. Bosks of full-sized tapia specimens reflect the absence of an intense fire for at least a decade. Many flourishing trees grow between rock outcrops where fire cannot easily spread. Fire also accounts for the lack of leaf litter. Instead grasses in the genera *Aristida, Loudetia, Trachypogon* and *Isalus* cover the ground under the trees. During fires, these herbs become the combustible material that spreads to and kills any tapia seedlings.

Tapia woodland covers about 130,000 ha in the two highland provinces of Antananarivo and Fianarantsoa. The former is the homeland of the Merina, the dominant Malagasy ethnic group; the latter is occupied primarily by the culturally similar Betsileo people. The Bara tribe, preeminently cattle herders, occupies southern Fianarantsoa province. A few small tapia groves also occur in the higher portions of Toliara (formerly Tuléar) Province. Distribution of tapia falls into three major and one minor zones within which individual groves, large and small, are surrounded by pure grassland (Fig. 2). Tapia copses range from 800 to 1,600 m above sea level and receive between 900 and 1,400 mm of yearly rainfall. Sclerophyllous leaves that reduce evapotranspiration and a spreading root system that garners soil moisture over a wide area help tapia to cope with the long dry season that extends from May to November.

In view of the rampant forest destruction on Madagascar, the sheer persistence of these woods is remarkable, especially given the status of the land and trees as commonheld property to which is attributed so much irresponsible land use. Both negative and

FIG. 1.—A pure grove of tapia trees *(Uapaca bojeri)* bordered by rice terraces in the Vakinankaratra region of Antananarivo Province. With very little competition from other plants, slow-growing tapia is able to spread its rounded crowns.

positive factors have spared tapia groves from total destruction. The slow growth of tapia wood and its low BTU yield have made this species unattractive as a source of charcoal. Elsewhere on Madagascar, charcoal makers and ironsmiths have illegally cut many tracts of remaining primary forest in response to the insatiable demand for domestic fuel and metal goods. Reinforcing the salvation of tapia groves on this otherwise denuded plateau is their affirmative value to man who has had an ethnobiological relationship with not just the plants, but also several resident invertebrate animals.

THE SILKWORM CONNECTION

Tapia is the host plant of a native silkworm *Borocera madagascariensis*, placed in the family Lasiocampidae (La Jonquière, 1972). It is thus not closely related to the domesticated Chinese silkworm *(Bombyx mori)* which belongs to the Bombycidea, lives on mulberry leaves, and forms the source of most of the world's silk. Collecting *Borocera* cocoons, processing them, unravelling the filaments to spin into thread, and weaving that into a silk called ***landibe*** have been part-time activities of highland rice-growing peasants for several hundred years.[1] Native silk is one of the more than a dozen fibers

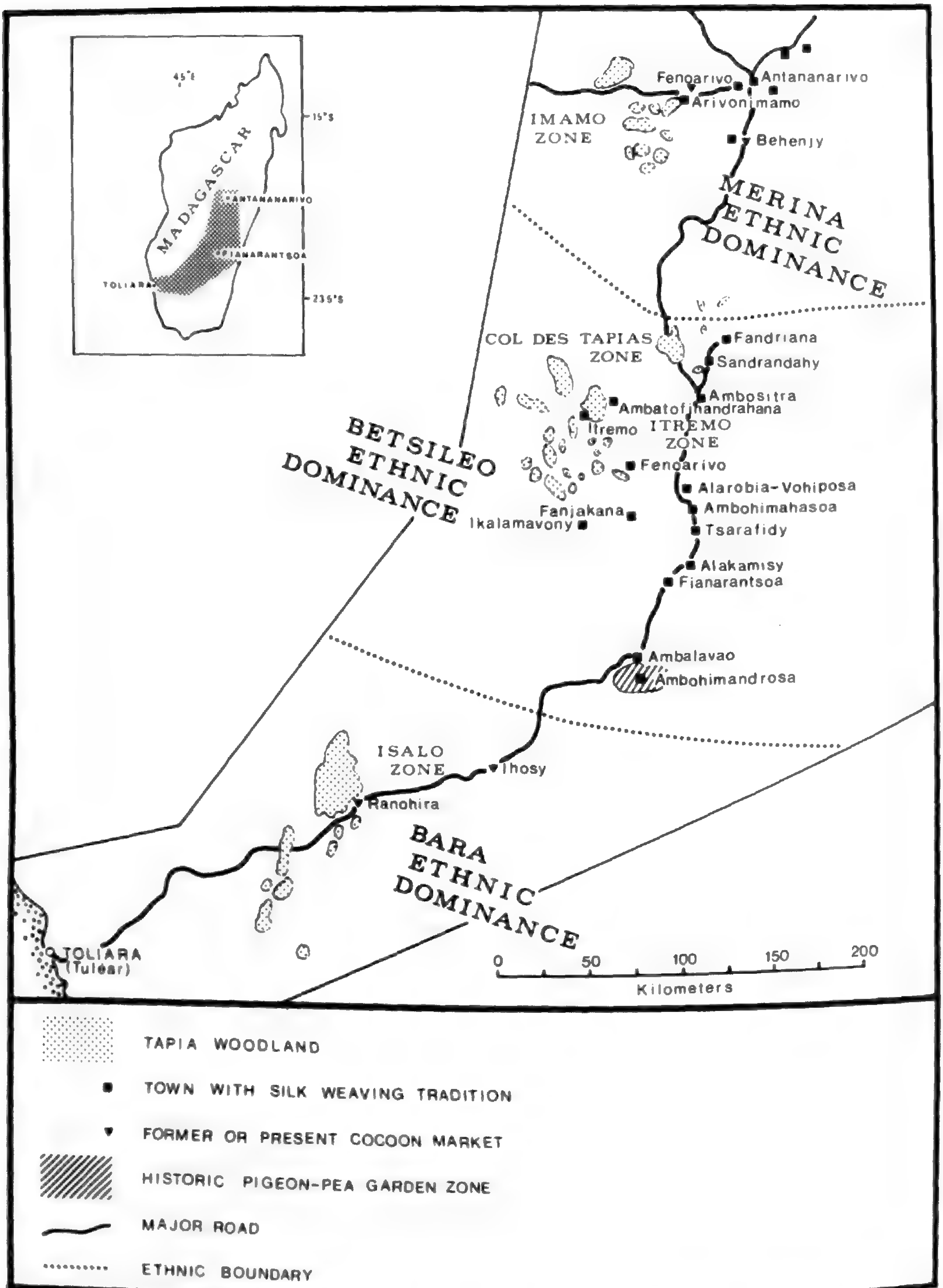


FIG. 2.—Location of tapia groves in Highland Madagascar and towns associated with ***landibe*** cocoon processing and native silk production.

used in the Malagasy weaving tradition which pre-dates European contact but which was later affected by Western influences.[2] ***Landibe*** owes nothing to the silk of China and Europe, called ***landikely*** in Madagascar. Under impetus of the French colonial administration, the domesticated Chinese silkworm was raised on the island, but *Bom-*

byx sericulture has now disappeared from most of its former sites except in several towns near Antananarivo.

Like all lepidopterans, *Borocera* goes through a multiphased metamorphosis from egg to larva (caterpillar) to pupa (chrysalid) and finally to the adult moth (imago). Unless fire intervenes, two generations ensue in a year, one that hatches in April-May, the other in November-December. Reproduction and growth are favored by periods of sunshine mixed with frequent rains. The female moth, three times larger than the male, lays 400-500 eggs which hatch after ten days and develop into hairy reddish-gray caterpillars with black and white spots. In their thirty-day feeding phase, they voraciously consume tapia leaves which are fleshy, high in water content, and slightly salty in taste. During this period, they undergo four molts after which they fashion cocoons either on a tapia branch or nearby tufts of grass. Before the pupa emerges to become a moth, large numbers of cocoons are collected as the raw material for native silk. Unlike the domesticated Chinese silkworm, the lifecycle of *Borocera* requires no human intervention, though informants indicate that the process has been facilitated in various ways. People have sprinkled tapia trees with water during dry spells; transplanted grass to certain locations near the trees on which larvae can spin their cocoons; and dug small trenches to form a barrier to caterpillar rambling. Emerging moths have been caught and tied to tiny sticks on which they deposit their eggs; the sticks are then hung from tapia trees. Tapia woods without the silkworms have been periodically restocked with eggs or cocoons brought from elsewhere. During the larval stage, children sometimes patrol the grove to scare away caterpillar-eating birds.

The native Malagasy silkworm is not exclusively dependent on tapia. Its caterpillars will feed on the leaves of other plants, among them *Dodonaea madagascariensis*, a native shrub which was occasionally cultivated in the past to serve as larval host, and three introduced crops: pigeon pea *(Cajanus Cajan)*, guava *(Psidium Guajava)* and loquat *(Eriobotrya japonica)*. Pigeon pea, called ***ambarivatry*** in Malagasy and gallicized to ***ambrevade***, was the most successful of these alternatives to tapia. Fields of this leguminous perennial, grown in other countries primarily for its edible seeds, were established for its leaves as caterpillar fodder. It was grown quite widely since at least the eighteenth century, but most intensively by Betsileo peasants in the Ambalavao region. Unlike other host species, pigeon pea grew fast enough to accept larvae only six months after planting. Cultivation of this crop allowed native silk production in populated zones in the Betsileo region where there was an abundant labor supply but no nearby tapia woods. As described by elderly informants who remember this activity from their youth, the female moth ***(samoina)*** was tied by her wings to a pigeon pea stalk until she laid her eggs on it. The eggs clusters were carried into their dwellings until they hatched, after which the young caterpillars—handled gingerly because of their urticant hairs—were returned to the fields to feed on their own. A ditch dug around the plantation obliged the roving caterpillars to spin their silky cases on ferns or grass planted in strategic places within the perimeter.

Three cocoon harvests a year, efficiently gathered from a narrowly confined area, characterized this indigenous silkworm raising. However, ***landibe*** cocoons from pigeon pea gardens were only half the size as those from tapia groves, yielded darker and somewhat coarser silk, and sold for substantially less. ***Landibe*** production reached its peak in the first decade of the twentieth century, facilitated by a commercial network, part of which is still in place. Some villages near the tapia groves grew into cocoon markets; others emerged as weaving centers. ***Landibe*** manufacture declined for a cascade of reasons. The domesticated Chinese silkworm produced with cheap island labor an aesthetically superior fabric for export, a market with which ***landibe*** producers could not compete. Then silkworm diseases brought from Europe were transmitted to ***landibe***, which reduced the manufacture of all kinds of silk. Concurrently, inexpensive factorymade cotton cloth, imported and then domestic, lowered demand for silk garments. This sharp drop in the use of native silk brought an end to the feeding of *Borocera* silkworms in the 1940s, and the remaning production fell back on the cocoons collected from tapia groves.

The long process of making ***landibe*** fabric begins with collection of the raw material in January-February and June-July. Cocoons from tapia groves that are remote from human settlement or frequently burned may be collected once a year or less. Size of the harvest varies greatly from one year to the next which, in the aggregate, amounts to between 10,000 and 30,000 kg for the whole island, Peasants whose main occupation is rice farming but who live near the woodland margins scour the groves armed with a long hooked pole or a forked stick to gather the oval gray cocoons which have projecting urticant hairs that can easily penetrate the skin and cause infection. In some tapia areas, cooperatives sanctioned by the state have exclusive rights to cocoon harvest, elsewhere families collect them from designated clumps of trees. Even in periods of relative abundance, the return for labor expended is low. Collectors wander over considerable distances to find the cocoons which are scattered on tapia branches and nearby herbs. Overlooked cocoons help to assure successive generations but a portion of the collected raw material is also set aside to supply imagos for the next reproductive cycle.

Depending on the area, the raw material is sold as collected or women prepare it for spinning (Fig. 3). At Ihosy, the largest cocoon market on the island, processed ***(masaka)*** cocoons sell for more than twice as much as unprocessed ***(akora)*** cocoons. Using a knife, the cocoon is cut lengthwise, turned inside out and the pupa is removed. The cocoons are then soaked in a boiling lye solution of water and tapia wood ashes to dissolve the gummy substance which bonds them into a tight case. Washed in clean water, dried in the sun, and rolled to loosen the filaments, the cocoons are then unraveled onto a stick. The spinner twists together several filaments, sometimes using a wooden spindle ***(ampela)***, to obtain a thread which becomes the raw silk, either dyed or kept in its natural color.

Weaving is still done on a simple horizontal loom ***(tenona*** or ***fanenomana)*** supported by four stakes placed in the ground (Fig. 4). The rather coarse fabric produced from ***landibe*** thread resembles tussah, a strong durable silk derived from different species of wild saturniid silkworms in Asia. Formerly some Malagasy clothing of the highland region

FIG. 3.—Washed ***landibe*** cocoons. Sandrandahy (Province of Fianarantsoa).

FIG. 4.—A Betsileo weaver in Sandrandahy moves the shuttle on her horizontal loom. These traditional Malagasy looms are believed to be patterned after those in Indonesia.

was made of native silk, including men's suits that reflected a European fashion. But the traditional use of silk fabric in Madagascar was for the ***lamba***, a rectangular piece of cloth still used by rural men and women to carry a baby or other objects or to be worn simply as a mantle. Locally distinctive designs of lambas emerged, each with its own dye, pattern, weave or fringe, among them the ***lamba andrino*** which was given to elderly folk as a sign of respect (Domenichini and Radimilahy, 1979). It, as well as most lambas and other island-made clothing, are now usually made of cotton. The major exception is the ***lamba mena*** or shroud from wrapping the dead.

BURIAL SHROUDS AND THE MALAGASY DEATH RITUAL

The two main highland ethnic groups, the Merina and the Betsileo, are the participants in an ancestor cult that requires the use of winding sheets.[3] So central to highland Malagasy culture is this belief that it has been integrated into the Christianity introduced by Protestant or Catholic missionaries from Europe. Before burial in the family tomb or temporary grave, a dead person is wrapped in a ***lamba mena***. Some years after that initial interment, the shriveled remains of the corpse are exhumed during a three-day event known as the ***famadihana***. Its high point is the "turning of the dead" ceremony in which the body fragments are placed in one or more new shrouds over the tattered shreds of the previous one and reburied in the family crypt. While ostensibly a death ritual, the emphasis is on revelry not eschatology. Dancing, drinking, feasting, singing and speechmaking reinforce the solidarity of an extended family whose members have travelled there sometimes from long distances.

Ceremonial tradition strongly favors a ***lamba mena*** made from ***landibe***. This totally indigenous fabric is valued for its durability and resistance to natural decay, not for its beauty. In recent decades ***landibe*** has taken on the aura of a material more appropriate for the dead than for the living, and most highlanders choose cerements of native silk as a way of demonstrating obedience to the wishes of their forebearers. This tradition of using ***landibe*** remains strongest among members of the old noble caste ***(andriana)*** who see shrouds as a mark of family honor and identity. On a symbolic level, a parallel is drawn between the cocoon that forms a protective cover for the immobile pupa and the ***lamba mena*** of home-woven silk that shields the revered ancestor from the elements.

In the late nineteenth century, Merina traders in the Betsileo country began to contract with local women to weave burial shrouds in large quantities which the merchants resold in Antananarivo and other Merina towns (Raherisoanjato, 1980:256). Before that commercialization, an individual commonly ordered one or more ***lamba mena*** from a weaver to be saved and used upon his or her death. This old practice subsists among noble Merina families, especially in cases where the couple is childless. If acquired before burial, the ***lamba mena*** becomes a floor covering in the honored northeast corner of the dwelling. Not until the early 1900s did the generalized use of the burial shroud spread from the Merina to the Betsileo and from the elite to all classes. This increased demand for ***landibe*** and commercialization of cocoons played some role in the protection of tapia groves.

To make a ***lamba mena*** for an adult corpse, one must sew together several fabric pieces, so limited is the size of the web which can be produced on the native looms. These composites range from four to eight pieces, each 2.50 m wide and 50 cm long and called a ***vitrana.*** Close to 3.5 kg of raw material (about 5,000 cocoons) are needed to make one large shroud which takes months of part-time weaving. ***Lamba mena*** (literally "red mantle") were originally dyed a russet color which explains its conventionalized name, but today most are left their natural beige or tan (Fig. 5). Rarer shades, reflecting a localized cocoon source, range from silvery gray to blackish-brown.

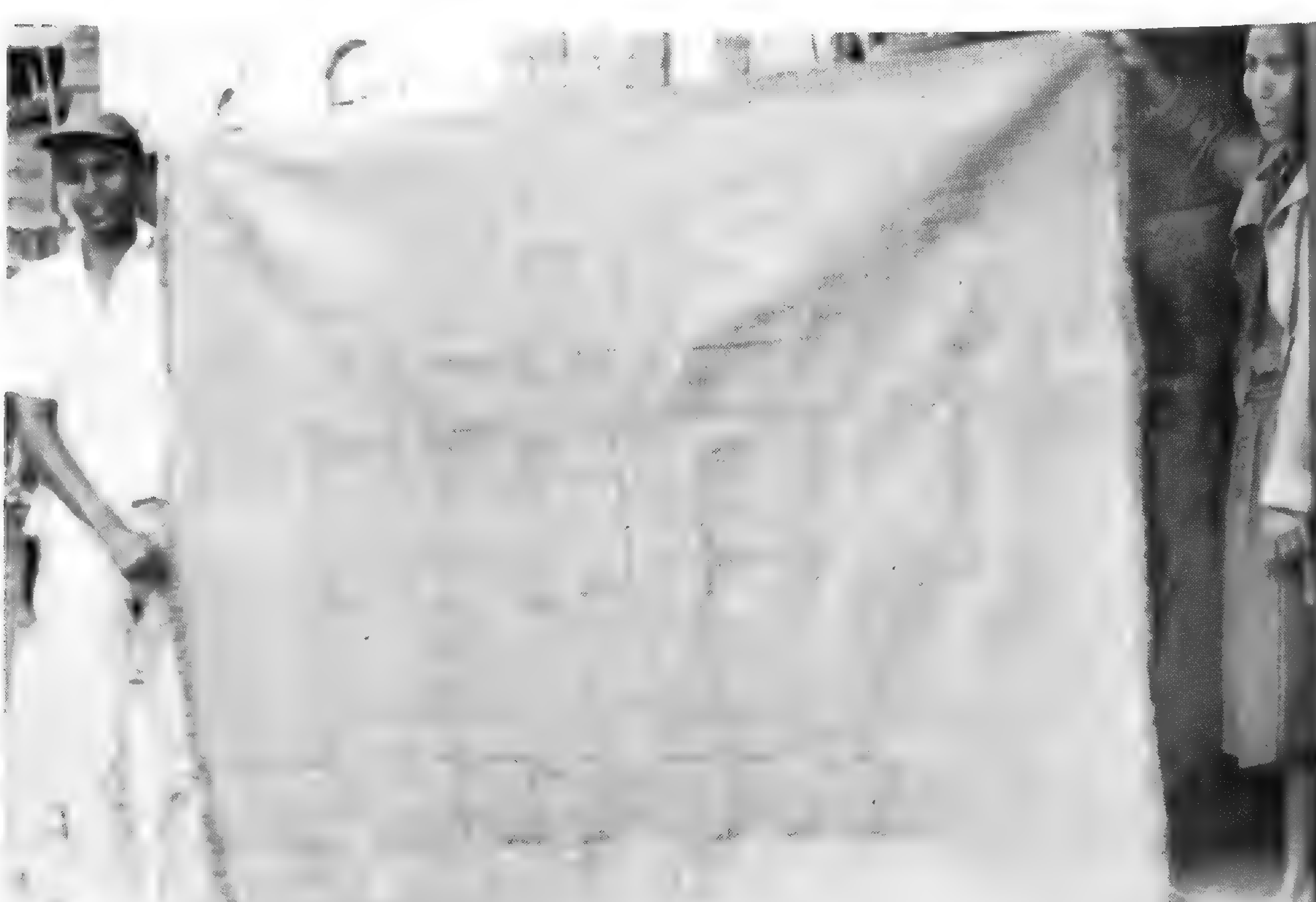


FIG. 5.—A large unfurled ***landibe*** to be used in rewrapping an adult corpse, one way in which the living keep their ancestors happy. Neither the texture nor the color fits the American image of silk.

Manufacture focuses today on Sandrandahy, a Betsileo town of ca 3,500 people where 80% of the women and girls are weavers. In an earlier time, Sandrandahy got its raw material from the tapia groves within walking distance to the north. Now about four metric tons of cocoons, unprocessed and processed, are brought in annually from as far away as Toliara.

The custom is a costly one: the retail price of just one ***lamba mena*** in 1985 ranged from 50,000 to 100,000 FMG (about $US100-200), depending on its size and quality. For a funeral, neighbors who are also kin contribute to the purchase of the shroud if the immediate family is unable to afford one. For the ***famadihana***, each close relative typically brings a new ***lamba mena*** to the event and other kinfolk are expected to offer money to help buy several more. The honored deceased may be bundled in as many as ten new shrouds, and any extra ones will be used to rewrap other bodies in the family tomb. The financial burden of providing numerous ***lamba mena*** as well as the other expenses explains why exhumation from a family crypt occurs only once or twice a decade. In a town of 4,000 people, about 100 ***famadihana*** can be expected in any one year. These extravaganzas are all concentrated between June and October, the post-harvest period when people have some cash, more free time, and travel is less impeded by mud.

TAPIA INSECTS AS HUMAN FOOD

The tapia tree is also the host of certain insects which people eat, a practice that has a strong tradition on the island.[4] Besides animal protein, insects provide occasional variation of texture and taste to the daily regime which is heavy in carbohydrates, primarily rice and manioc. Meat is not an everyday part of the diet; the dominant livestock, cattle, are prestige animals and are slaughtered only for special occasions. Entomophagy may have been especially encouraged in areas such as the Isandra valley where the Betsileo there followed a taboo against eating beef and rice at the same meal (Dubois, 1938:126).

Lepidopteran insects in two phases of metamorphosis—the caterpillar ***(fanday)*** and the chrysalid ***(soherina)***—are collected in the tapia groves. Of the two, chrysalids, especially of the *Borocera* silk moth, are the preferred delicacy and have long been sold in peasant markets (Ellis, 1859:367; Osborn, 1924:324). They are also available in markets in the capital city of Antananarivo from October to April, brought there from a 50 km radius. *Borocera* pupae are byproducts of the silk processing described. An incision is made in the cocoon to remove the chrysalid; if allowed to mature and emerge as a moth, the filaments would be useless for spinning. Chrysalids are often returned to cocoon harvesters in partial payment for their work. The pupae of *Tagoropsis* are gathered by scratching the ground to uncover them. The caterpillar in this cocoonless genus descends the tapia tree to undergo metamorphosis in the loose soil or under dead leaves. In two or three hours, collectors can fill a 40 kg sack of the pupae. they are killed in boiling water and eaten that way, or they are fried in oil; some people also cook them in the hot ashes of the hearth fire. Their flavor resembles that of fish.

Tapia is host to three species of edible caterpillars, the most important of which is ***bokana*** whose imago is a large saturniid moth. The insect under this name may actually fall into half a dozen different closely-related species of *Tagoropsis*. Beginning in February, ***bokana*** larvae develop from the eggs laid by the female moth. For six to eight weeks, the blackish caterpillars consume the tapia leaves, but only at night. During the day they hide from predators in the sinuous recesses of the bark or at the base of the trunk (Fig. 6). Some peasants assert that large populations of ***bokana*** in a grove coincide with a relative absence of ***landibe*** and that the reverse is also true. This apparent intergeneric competition is particularly noticeable west of Antananarivo where ***bokana*** is abundant and *Borocera* rare since the 1950s. For about half the year, cater-

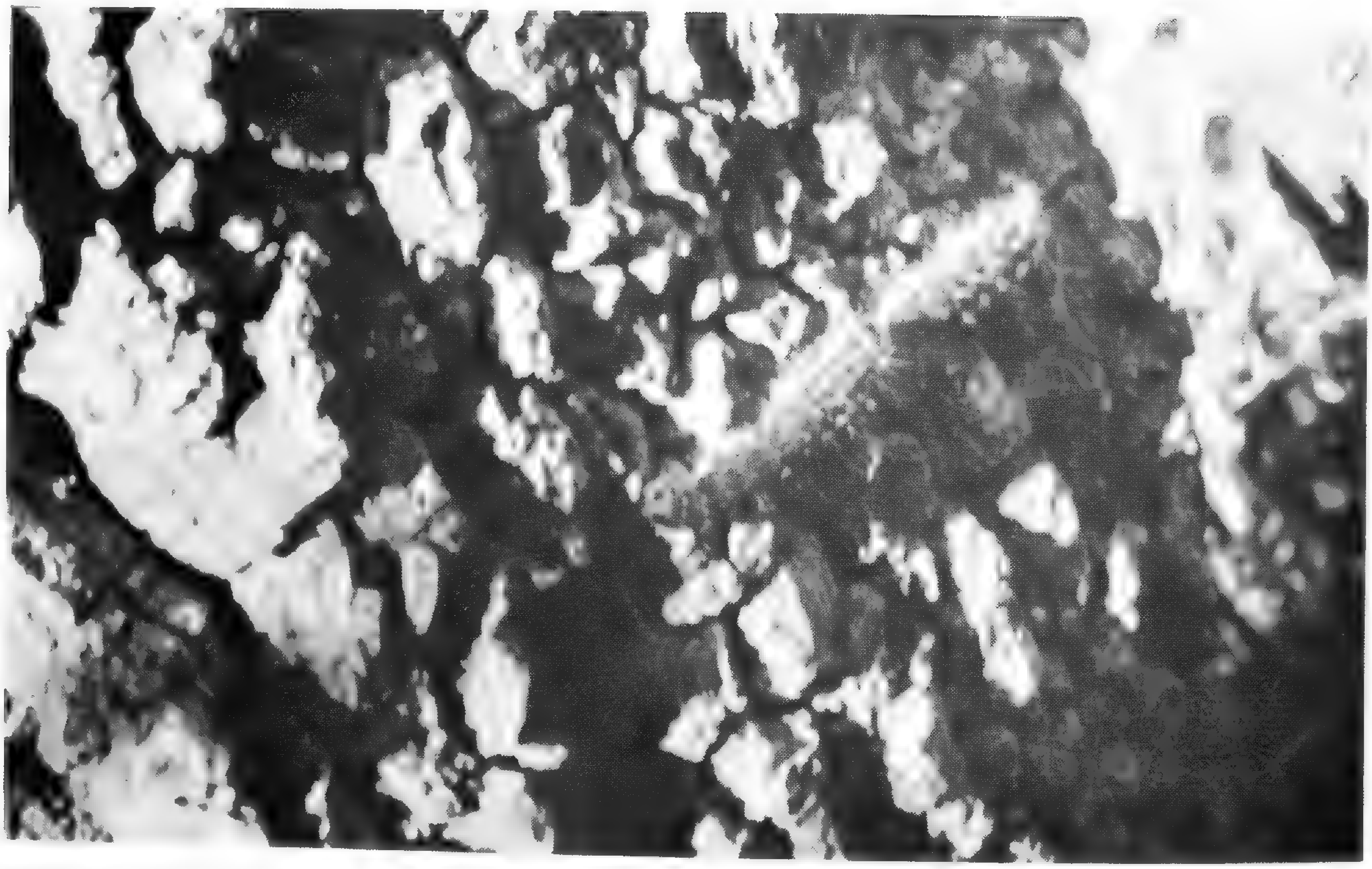


FIG. 6.—An edible ***bokana*** caterpillar *(Tagoropsis* sp.), 3 cm long, crawls over the thick sinuous bark of a tapia tree in a grove near Masinatsimandrano, west of Arivonimamo.

pillar collectors, often children, enter the tapia groves with pails and sticks. The creepy-crawlies are brought back to the village where they are decapitated, soaked in salt water, and fried in oil. During its period of abundance, ***bokana*** supplements the mid-day meal of rice and/or manioc of many peasants in the tapia zones. One family consumes about two kg per week, an amount which increases in September when the household rice supply nears depletion. Caterpillars are also sold in markets to those townspeople who also eat them. Local informants assert that ***bokana*** consumption was formerly more common than it is at present. European missionaries and administrators on Madagascar undoubtedly prejudiced some people against eating caterpillars. High-caste individuals ***(andriana)*** refuse them, a possible reflection of their acculturation to Western values and food alternatives rather than a class-dictated taboo. Descendants of the former slave caste ***(mainty)***, which includes many impoverished people less touched by foreign ideas, appear to be the most avid caterpillar consumers.

Two other larvae are eaten much less. ***Saroy*** *(Antherina suraka)*, a black caterpillar with spots of green, yellow and turquoise, has been at times so abundant that it partially defoliates the tapia trees. ***Saroy*** is especially collected in July-August. Fried in oil, its taste is much less appreciated than ***bokana***. A third edible kind is *fangotsoana* or *fangatsika*, which apparently includes several species of *Borocera* related to ***landibe*** but not useful as silk (La Jonquière, 1972). They are reportedly a human food source primarily during famines.

OTHER TAPIA RESOURCES

Tapia supplies additional products, not the least of which are the edible fruits, about the size of a cherry and containing vitamin C, that ripen in October and November (Fig. 7). The fruit is always gathered from the ground to circumvent a Madagascan taboo that prohibits picking those still attached to the tree; if violated the rice crop will be ravaged by hail. Sale of tapia fruit in highland markets late in the year supplements family

FIG. 7.—Betsileo peasant near the Col des Tapias holds a dried tapia fruit in his fingers.

incomes. A less seasonal though minor product is tapia bark, stripped from the trees and used in Malagasy folk medicine to relieve diarrhea.

Dead tapia trunks and fallen or broken boughs are gathered as combustible. Although light in density and quick-burning which make it less than the ideal firewood, its availability is a major advantage in the fuel-starved highlands. Residents near tapia groves have traditional rights to gathering (but not cutting) the wood, a year-round activity most assiduously done in November before the onset of the rainy season. Neighboring hamlets get their fuel supply from this source, and may also sell some of it elsewhere. Collection of tapia deadwood has a further value of cleaning the groves of accumulated trash which, if allowed to build up and burn, results in a firestorm that destroys the whole grove.

A nocturnal yellow moth, *Argema mittrei*, forms still another item of economic interest in the tapia woods. The adult male is one of the world's largst lepidopterans, having a wingspan of 18 cm and a length of 21 cm, part of which is a ribbon-like appendage (Griveaud, 1961:54-59). People supplement their incomes by capturing the male to mount and sell to butterfly fanciers and tourists. Netting often damages the specimen, so the preferred method is to raise them in captivity. Tapia trees and other plants are scrutinized for *Argema* egg cases and the unmistakable silver-colored perforated cocoons which are collected for their eventual metamorphosis into an imago ***(lolo*** in Malagasy).

TENUOUSNESS OF THE ETHNOBIOLOGICAL SYSTEM

The tapia-protein-silk association in Highland Madagascar is vulnerable on three fronts. Although it is clearly a "fire-type community," tapia groves can be nevertheless eliminated by an intense burn and replaced by pure grass such as now covers most of the region. Deliberately set blazes have victimized all wooded areas on Madagascar, whether they be vestigial patches of the climax forest, tapia bosks, or eucalyptus and pine plantations (Fig. 8). If mature tapia trees manage to survive fire, their fruit and useful insect populations do not. In the Itremo zone west of Ambatofinandrahana, cocoons are abundant in cycles of one year out of five, and in some places in the Imamo zone west of Arivonimamo, the sparse cocoon populations are not worth the harvest effort.

Wholesale felling of tapia trees for fuelwood is a second threat. Since the mid-1970s, oil and butane gas, all which must be imported, cost more than twice as much as wood or charcoal per kilocalorie generated. That sharp price difference has intensified the pressure on remaining island forests and woodlots. As the gap widens between the rate of tree cutting and replanting, the demand for cheap cooking fuel could soon sacrifice the more accessible tapia groves. The probable demise of native silk manufacture is a third factor working against the system. No modernization of the manual process has

FIG. 8.—Aftermath of a *feu de brousse* that swept through a tapia grove north of Ilaka (Province of Fianarantsoa) weeks before this photo was taken in September 1983.

occurred; a French attempt earlier in this century to reorganize and integrate this indigenous activity failed. Meanwhile, the number of weavers has greatly declined from that of several decades ago and many rural communities have totally abandoned this work. These changes have forced up labor costs which, when combined with high middleman profits, place the ***landibe*** burial shroud as a major expenditure. One ***lamba mena*** fetches a price that exceeds a third to a half of the annual cash revenues of most people. High cost of the shroud, especially in the face of deteriorating family incomes everywhere on the island, makes it difficult to meet one's kindred obligations. A practice whose function is primarily social is more likely to be modified than one directly related to subsistence security. Given its role in Malagasy culture, the shroud concept is outlasting the native silk association. Indeed, a cotton ***lamba mena*** costs one fifth, and those of Chinese silk ***(landikely)*** one third as much as ***landibe.*** If ***landibe*** is totally replaced in mortuary ritual, the main rationale for maintaining the tapia groves will disappear.

Whatever the fate of Madagascan folk ecology in coming years, this specific relationship exemplifies an important concept too often overlooked. "Culture" and "nature" are not the independent categories that we often like to ascribe to them. In some places, plant and animal populations that we normally classify as "wild" and thus part of the biophysical environment owe their presence to human intervention. This realization by itself refutes the dubious notion that technologically simple societies have their subsistence patterns dictated by an immutable Nature.

NOTES

[1]Silk is mentioned in the journals of most early European visitors. The best published descriptions of native silk production date from the French colonial period: Gouvernement (1899:II); Cordemoy (1901); Grangeon (1906); Martonne (1906); Anonymous (1915); and Dubois (1938:282-294).

[2]Raw materials formerly woven by the Malagasy included several species of native wild plants, three introduced fiber-bearing species (agave, hemp and banana) and even the flossy dragline of a spider called ***halabe*** *(Nephela madagascariensis)*. Now only cotton, rafia, and silk survive as materials still woven.

[3]Bloch (1971) provides the most trenchant analysis of the death cult among the Merina; Kottak (1980:211-259) describes it among the Betsileo.

[4]The Malagasy inventory of edible insects is large and includes species in at least seven orders: Lepidoptera, Orthoptera, Hemiptera, Homoptera, Neuroptera, Hymenoptera and Coleoptera. Widespread over the island as sources of food are migratory locusts *(Locusta* sp and *Nomadacris* sp), easily captured as they swarm at certain times of the year. Crickets especially the ***sahobaka*** *(Brachytrypes membranaceus)* are trapped as they emerge from their nests made in alluvial soil. A third preferred comestible is the ***sakandry*** *(Pyrops madagascariensis)* a fulgorid planthopper that parasitizes Lima bean and related plants. Dried, this insect is much appreciated, especially in the Majunga region.

ACKNOWLEDGEMENTS

Field work on this topic in 1983 was funded by a Fulbright award to the author in the Africa Research Program of CIES. I wish to acknowledge the assistance in Madagascar of Joselyne Ramamonjisoa, Jean-Gabriel Rajaonarison, and Didier Rakotovao.

LITERATURE CITED

ANONYMOUS. 1915. Étude sur la sericiculture à Madagascar. Bulletin Économique (Mad.). 15:1-17.

BARTLETT, H. H. 1956. Fire, primitive agriculture, and grazing in the tropics. Pp. 692-720, *in* Man's Role in Changing the Face of the Earth (W. L. Thomas, Jr. ed.) Univ. Chicago Press, Chicago.

BLOCH, M. 1971. Placing the Dead: Tombs, Ancestral Villages and Kinship Organization in Madagascar. Seminar Press, New York.

CORDEMOY, H. 1901. Les soies dans l'extrême orient et dans les colonies françaises. Annales de l'Institut colonial de Marseille. 8:1-112.

DOMENICHINI, J. P. and C. RADIMILAHY. 1979. Lamba malagasy: étoffes traditionnelles malgaches. Association culturelle franco-malgache, Antsirabe.

DUBOIS, H. M. 1938. Monographie des Betsileo (Madagascar). Institut d'Ethnologie, Paris.

ELLIS, W. 1859. Three Visits to Madagascar during the Years 1853-1854-1856. London.

GOUVERNEMENT GENERAL A MADAGASCAR. 1899. Guide de l'immigrant à Madagascar. Armand Colin, Paris. 3 vols.

GRANGEON, M. 1906. Étude sur le landibe. Revue de Madagascar. 8:673-688.

GRIVEAUD, P. 1961. Insectes: lépidoptères: Eupterotidae et Attacidae. Faune de Madagascar. 14:54-59. Institut Scientifique de Madagascar, Antananarivo.

KOECHLIN, J., J. L. GUILLAUMET, P. MORAT. 1974. Flore et végétation de Madagascar. J. Cramer, Vaduz, Lichtenstein.

KOTTAK, C. P. 1980. The Past in the Present: History, Ecology, and Cultural Variation in Highland Madagascar. Univ. Michigan Press, Ann Arbor.

LA JONQUIERE, Y. 1972. Insectes: Lépidoptères. Lasiocampidae. Faune de Madagascar. 34:171-195. ORSTOM and CNRS, Antananarivo and Paris.

MARTONNE, E. 1906. Fianarantsoa et le Betsileo central. Revue de Madagascar. 8:215-240.

OSBORN, C. S. 1924. Madagascar: Land of the Man-eating Tree. Republic Publishing Co., New York.

RAHERISOANJATO, D. 1980. Origines et évolution du royaume de l'Arindrano jusqu'au XIX siècle. Unpubl. Mémoire de Maitrise d'Histoire, Faculté des Lettres, Université de Madagascar.

SAUER, C. O. 1956. The Agency of man on the earth. Pp. 49-69, *in* Man's Role in Changing the Face of the Earth (W. L. Thomas, ed.) Univ. Chicago Press, Chicago.

J. Ethnobiol. 5(2):123-133 Winter 1985

MALAY MEDICINAL USE OF PLANTS[1]

CHRISTINE S. WILSON
Department of Epidemiology and International Health
University of California
San Francisco, CA 94143

ABSTRACT.—Use of plants for medicinal purposes was observed and recorded during extended study of the effects of culture on diet and health in a Malay fishing village. Beliefs about properties of plants and their parts were elicited by informal questioning of inhabitants and unstructured interviews of traditional healers. Treatment that was efficacious appeared to result from empirical experiences. Some uses were based on imputed heating or cooling properties of the substances, others were magical.

INTRODUCTION

Earliest written literature in the Malay language was in Perso-Arabic script (Winstedt 1969), which probably was brought to the Peninsula by Muslim traders from Arabia and India, who had been active in the region beginning about the tenth century, A.D. Although their religion, Islam, received impetus for spread in this part of Southeast Asia when the Sultan of Malacca was converted in 1414 (Burling 1965), there is evidence for earlier Islamicization in Terengganu, on the Malayan East Coast, where the present research was conducted. A stone or stele with religious instructions in Malay in Arabic script, found in this century in the ancient capital, Kuala Berang, is believed to have been inscribed in the 14th century, although there have been disputes among scholars on the actual date (Coedes 1968, Winsted 1969, Syed Mohd. Naguib 1970). Despite a subsequent literature of folk tales, legends, histories, legal digests and poetry (Winstedt 1969), traditional Malaya herbals seem not to have been produced in Malay. Writings on medical topics were limited prior to extensive influx of Europeans into the region.

A body of systematic information on Malay use of plants in medical treatment was recorded by bilingual English civil servants in the 19th and 20th centuries. Skeat's *Malay Magic* (1900) and Burkill's *Dictionary of the Economic Products of the Malay Peninsula* (1966) are familiar to ethnobotanists and anthropologists who have worked in Malaya. Burkill's two volumes in particular have pertinent information for researchers in the tropics in pharmacology, ethnobotany and anthropology, as well as in medicine and nutrition. Gimlette and Thomson's *Dictionary of Malay Medicine* (1939) and Gimlette's *Malay Poisons and Charm Cures* are also germane to this topic. Because Gimlette's two works were initially published 40 to 60 years ago, and reprinted in the Oxford-in-Asia series (1971), they may be less known to western researchers.

This paper presents a more recent Malay folk pharmacopoeia than that found in the foregoing publications. I learned of it during ethnographic study of diet and health in a Terengganu fishing ***kampung*** (village) on the East Coast of the Peninsula. These treatments, orally transmitted from generation to generation and resembling those cited by Gimlette and Thomson (1939), were in use in the late 1960s and early 1970s during my first two study periods in the community. Their persistence may be related to continued practice in the village by a number of traditional medicine men—***bomoh***—and two traditional midwives—***bidan kampung***—who prescribed roots, barks, leaves and other plant parts for a variety of disorders that were locally perceived to be alterations of normal health. These treatments were seldom administered singly as medications are prescribed by western medical professionals. Instead they were accompanied by charms, spells or incantations, and by "blowing" ***(tiup,*** a practice that may, if prolonged, put the medium into a state of trance), in the manner described by Skeat (1900) and Gimlette and Thomson (1939). Villagers also prescribed these medicines for self-diagnosed conditions, and recommended them to family and friends.

Neither the pharmacopoeia nor the compendium of perceived illnesses presented here is complete. Medical problems and their treatment, save for those affecting diet and nutritional status, were not the primary focus of my research. This paper is based on what I observed or learned regarding ***kampung*** approaches to illness in day-to-day conversations with villagers, supplemented by semistructured interviews conducted with the traditional healers.

THE KAMPUNG AND ITS PEOPLE

This community of seafishers and their families, totalling just under 600 people, was economically and dietarily dependent on the sea. Fish was the chief source of income and the major contributor of dietary animal protein. The diet was typically a meal of large amounts of rice with smaller quantities of fish prepared in one or more ways, a relish of chili peppers and prawn paste, and an occasional side dish of vegetables, eaten twice a day. (Breakfast was considered a "snack," and was most often a Malay cake and coffee.) The population by its own account was generally healthy, and medical and dietary surveys made in the village confirmed this belief (Wilson 1970, Wilson *et al.*, 1970). There was, however, a certain amount of complaining, some of which probably was psychosomatic in nature, a legitimate way in which to get individual attention in an otherwise egalitarian society.

These Malays, in common with other Southeast Asians, adhered to a folk medical system based on Hippocratic-Galenic humoral theories, that, together with their Islamic religion, was brought to them by the Arabic traders and other followers of Mohamed. This system assigned "heating" and "cooling" qualities to foods, ingestants, disease states and physiologic alterations or abnormalities (Wilson 1981). These Malays categorized meat, eggs, tapioca (manioc, *Manihot utilissima),*[2] coffee and certain common spices as "hot," fruits and vegetables as "cold." They considered rice and fish, the backbone of the diet, to have neutral qualities. As has been noted for other societies that hold these beliefs (Foster and Anderson 1978), consumption of foods to which these qualities were imputed was increased or restricted only when it was felt that the individual's physiologic state required such an alteration due to illness or a marked change such as pregnancy (Wilson 1981).

Medicines, like other ingestants, were categorized within this humoral system. They included ***pinang,*** "hot" betel nut *(Areca catechu,* properly a seed), chewed throughout South and Southeast Asia in a quid containing calcium carbonate powder made from chalk or pounded seashells, and gambier, essence of the leaves of a woody vine *(Uncaria gambir),* wrapped in a leaf of the pepper *Piper betel.* The alkaline calcium carbonate releases an addictive, mildly narcotic substance from the nut. It may therefore be considered to have pharmacologic properties, although its chief use in this village, aside from an oral activity, was as a "hot" substance chewed by women after child delivery, when eating and using "hot" things was recommended. Old folks in the village reported they sometimes chewed ***sireh*** (Malay word for the pepper leaf and, by extension, the quid) to clean their teeth. The quid and most of the saliva it stimulates were spat out. The nut is known to have vermifugic properties (Burkill 1966).

DATA COLLECTED: MALAY-PERCEIVED DISORDERS AND THEIR FOLK TREATMENT

In the second phase of this research, when I was well acquainted with and accepted by the village, a medical student from my university and I queried four of the ***bomoh*** in the ***kampung,*** using open-ended interviews to learn how they classed and perceived health disorders. Much of this paper is based upon excerpts from those interviews. Some of what they reported I had not read of previously or encountered in the country. I was unable to define or translate some of their terms into English using standard Malay dictionaries (Winstedt 1965, Wilkinson 1969). East Coast word usage and pronounciation differ from those of other Malay speakers (Brown 1935). In translating some of the statements of these men I had to guess meanings of particular phrases or words from context. I am, however, reasonably certain of the correctness of the information which this paper reports.

I have pointed out previously (Wilson 1981) that Malays resemble people in other emergent nations in recognizing some of the serious disturbances of health westerners define as diseases, while at the same time possessing an array of folk-defined disorders. Preferred treatment of the latter was ***kampung*** medications of "natural" substances such as plant parts administered together with the use of ***jampi*** (spells)—magical incantations or invocations, done by the practitioner in a trance-like state—and censing ***(rabun,*** passing the patient or afflicted part through smoke), all performed by an experienced ***bomoh.*** The medicines used were considered ***penawar***—antidotes.

Each ***bomoh*** specialized to some extent. The esteemed elder ***bomoh*** had practiced full-time for many years and was expert in treating mental disorders. Of the three who functioned on a part-time basis one used only ***jampi***—spell-saying and "blowing"—and ***air tawar,*** water over which incantations had been said. He used no medicines by ***kampung*** or western definition. There was otherwise general agreement among these men regarding types of medicines to be used and conditions for which these medications were indicated. A few examples may illustrate (Table 1).

Beguk or ***bengkak***—swellings of the throat or neck. Whether actually mumps, goiter, or nonspecific swollen lymph nodes, these conditions were treated by washing the affected part with a liquid made from bark of a tree they did not name, soaked in water.

Bengkak dalam—swollen prostate. This was treated by "hairs" of the bamboo tree (a species of *Bambusa),* sometimes mixed with roots or medicinal powder, taken internally. Such Malay medicines were also recommended for testicular problems.

Seduan—upper respiratory infection. The local description of this condition closely resembled sinus infection. Characterized by a clogged, stopped-up nose, and thought to be caused by ***badi,*** an "evil influence," it was treated by giving the fruit ***sentul*** (*Sandoricum indicum*, which is not nutritionally remarkable). Alternatively the sufferer recited a prayer to Allah or King Solomon while bathing, at the same time throwing water on the nose. Liquid from roots or wood not specified by villagers was also applied externally. Despite frequency of mild upper respiratory infections, ***seduan*** was much feared as having the potential to lead to damaging, irreversible conditions. ***(Seduan*** was defined by Gimlette and Thomson (1939) as a serious malady such as lupus or syphilis.)

Sawan—this Malay-defined affliction of small children was seen as two different syndromes in this village. The first was thrush, or stomatitis, an infection of the mucous membranes of the mouth caused by the fungus *Candida albicans*. An infant whose relatives believed he was suffering from this "hot" disorder was treated by rubbing on his abdomen the cut end of a young coconut. A powder made from leaves of the ***kemunting*** (rosemyrtle, *Rhodomyrtus tomentosa)* and *gajus* (cashew tree, *Anacardium occidentale*; Fig. 1) together with a cashew bud was first placed on the coconut.

TABLE 1.—Some Malay-defined illnesses and treatments.

Disease or condition	Treatments
Beguk (swelling of throat, neck)	External: Liquid from (unnamed) tree bark
Bengkak dalam (swollen prostate)	Internal: Mixture of bamboo "hairs" *(Bambusae)* with unnamed roots
Seduan (upper respiratory infection)	External: prayers while throwing (unnamed) bark or root liquid on nose Internal: ***Sentul*** *(Sandoricum indicum)* fruit
Sawan (thrush, infant disorder) (first definition)	External: Powdered leaves of rosemyrtle *(Rhodomyrtus tomentosa)* and cashew *(Anacardium occidentale)* rubbed on stomach using cut-open young coconut
Sawan (convulsions, infant disorder) (second definition)	External, preventive: Amulet ***(tangkal)*** on cord fastened on neck, wrist, ankle, or abdomen
Cacing (intestinal parasites)	External, preventive: ***Tangkal*** as above Internal: coconut water, "blessed" water, ***kuini*** (horse mango, *Mangifera odorata)*
Batuk (cough)	External: Steam with or without ***raja*** *(Dracaena congesta)* root infusion, liquid from ***cermai*** (Malay gooseberry, *Ciccada acida)* root on chest
Demam (fever)	External: Steam Internal: ***Raja*** *(Dracaena congesta)*, other roots in liquid, "blessed" water
Barah (cancer; boils)	External: Poultices of leaves, ***medang*** (laurels), ***gaji baju*** tree (unidentified)
Kurap (ringworm)	External: Leaves of ***kupang*** shrub *(Cassia alata)*

FIG. 1.—Cashew tree in a ***kampung*** dooryard showing fruit buds and leaves.

The second condition diagnosed as ***sawan*** by these Malays was convulsions. Villagers thought they were caused by the individual being startled in sleep, and feared they might be fatal to babies. This "hot" disorder was diagnosed locally by the condition of the child's mouth and tongue, and by frequent crying. Convulsions in toddlers were prevented by fastening an amulet or charm—***tangkal***—around the child's neck, wrist, ankle, or more commonly the abdomen, "when the baby teeth finish coming"—at the age when the child began to walk, 18 months to 2 years. The amulet was made by the ***bomoh***, who "blew" on it to make it efficacious. It consisted of a small piece of cloth containing numbers and words or verses in Arabic from the Koran, into which some "spiced vegetables from the shop" (not specified) were sewn. The cloth portion of the amulet, which was about 1.25 cm,[3] was attached to a cord. The ***bomoh*** fastened it on the child. It remained in place for several years until it fell off, when its protective powers were assumed to be no longer needed. A few villagers said the ***tangkal*** were used to prevent children from becoming ***amuk*** (frenzied) or surly.

The two clinically different manifestations of ***sawan*** seen in this community may be due to local mispronounciation of the correct name of the first condition described. Termed ***sawan*** in the village, it should more properly be called ***seriawan***, Malay for thrush or sprue. The full Malay name for thrush is ***sakit seriawan lidah*** (Gimlette and Thomson 1939), literally thrush illness (of the) tongue.

Cacing[3]—worms. ***Tangkal*** were more commonly fastened on toddlers to prevent ***cacing***, a nonspecific term for ubiquitous intestinal parasites that westerners would, nonspecifically, call "worms." *Ascaris lumbricoides*, the common nematode roundworm, was the most prevalent, although hookworm and *Trichuris trichiura*, whipworm, were also present (Wilson 1970). Medically, it is sensible to fasten the amulet for this purpose at this age, since this is the time the child begins to run about, away from the comparative cleanliness of the family home, and to encounter a variety of parasitic organisms in the environment. Parents recognized "worms" as a cause of appetite depression. Some knew that certain "worms" could be acquired from going barefoot out of doors, and urged footgear on their children when leaving home. Those whose offspring had become infested bought liquid vermifuge from a local shop, if they could afford it. One of the ***bomoh*** reported that an effective means of ridding a child of worms was to feed the fibrous wild mango called ***kuini*** *(Mangifera odorata).* He believed the fibers would "net" the parasites and sweep them from the intestine, but he warned the treatment would also cause stomach ache. Other village worm remedies were to drink coconut water, which is sometimes considered ***bisa*** (poisonous), and ***air tawar,*** water which had been "blessed" by incantations and blowing. One of the ***bomoh*** though worms could cause fever in children.

Malays used to believe that intestinal pin-worms or thread-worms ***(cacing kerawit)*** could rise to a child's eyes. They blamed these "eye worms" for the drying and clouding of the cornea, known medically as xerosis, that results from prolonged vitamin A deficiency. Excellent sources of provitamin A such as papaya, together with the animal protein food needed to transport this vitamin in the body—fish, eggs—were prohibited to children because these foods would be "too stimulating" to the worms (McKay 1971), spurring them to ***naik mata*** (rise to the eyes). The senior ***bomoh*** riveted the attention of the interviewers by commenting that "cloudy sight" in a child (corneal opacity, another symptom of vitamin A deficiency) might be cured by goat liver, which we knew to be an excellent source of vitamin A. However, his use of it was magical rather than medical—he smeared the material on the eyelid. Whether any of the vitamin in the liver could be absorbed through the skin or enter the tear duct, subsequently to reach the blood stream for transport to the eye, remains to be determined.

Batuk—cough. Several cures for cough were reported that made use of plant parts. Some were self-administered. The elder ***bomoh*** used a western folk treatment, steam from the tea kettle. He also recommended taking syrup or drops intended for children that could be bought from the shop, or external application of a powder "like stone" to the chest. Another ***bomoh*** put the root of a shrub called ***raja*** *(Dracaena congesta)* into hot water to make steam. A third said cough comes from ***kembang,*** swelling in the stomach. He treated it with a mixture of tree roots and the seed of basil *(selaseh, Ocimum basilicum),* and rice, to be taken internally. Self-treatment of cough usually involved making a liquid from bits of tree roots and bark, to be drunk or applied externally to throat and chest. One root that was identified was that of the Malay gooseberry tree or ***cermai*** *(Cicca acida).*

Demam—fever. Malays perceive a number of different types of fever. The elder ***bomoh*** treated the type caused by "spiritual fire" (possibly spirit possession) by unspecified Malay medicines and steam from the kettle. Another ***bomoh*** thought the fever that occurred in the dry season following monsoon flooding was caused by ***kuman,*** germs, a case of syncretism with western ideas. He showed us a variety of ***ubat kayu penawar,*** wood and root antidotes suitable for treating fever. He could not remember names of all the trees from which they came, but they included pieces that were black, yellow and white, all of which could be "eaten" (ie., made into a decoction and ingested) for fever. One tree he knew was ***raja,*** the *Dracaena* mentioned above. The ***bomoh*** who treated only by incantation and "blowing" would make ***air tawar*** to be drunk by a child with fever. He also "blew" on the sick child. His pragmatic approach to treatment was suggested by his remark, "Sometimes it works, sometimes it doesn't."

Panas kepala—"hot" head. For the "hot" head that accompanies colds in children, one ***bomoh*** used shots and leaves, apparently as poultices. He called the plant he used for this purpose ***baji kepala*** (meaning "split head"). The plant could not be identified. Small wood shoots were also used.

Pening kepala—dizziness. Small wood shoots made into a decoction were given for "reeling head," another rather common Malay-defined affliction. This condition more than others cited appears to be about equally psychosomatic and physiologic in origin.

Barah—cancer. East Coast Malays fear cancer as much as western people do. However, their word for tumor also means abscess or boils. The old ***bomoh*** indicated there were nine kinds of ***barah.*** He treated some with external applications of material from the tree ***gaji baju,*** which I was unable to identify (the name translates "wage shirt"). He also made poultices of many kinds of laurels *(Lauraceae)*, called ***medang.***

Other folk ailments—a few other Malay-defined health problems may be mentioned. Women often complained of ***medu,*** nausea or heartburn accompanied by flatus and eructation, that they believed was caused by eating "cold" things—fruits and vegetables—or sour foods, which were "bad luck." Treatment, aside from avoidance of such foods, was to take a pill (possibly a commercial antacid), followed by coconut water to counteract any bad effects of the pill. Some people described digestive disorders as ***"ta' sedap makan;"*** eating wasn't tasty. They blamed these conditions on constipation, but they may well have been due to the presence of intestinal parasites, or the normally spicy diet. ***Kudis,*** infected scratches, or lesions caused by the scabies mite *(Sarcoptes scabiei)*, to which children were particularly susceptible, was believed to come from the bones, and could only be cured by the ***bomoh*** by "blowing" and incantations. Some disturbances of child health that were not readily diagnosed by local people were treated by censing—the child was passed back and forth through smoke from a fire into which tobacco or herbs had been sprinkled. ***Kurap,*** ringworm, as well as other frequent forms of fungal infections of the skin caused by *Tinea* organisms that left scaly depigmented lesions, was also thought to "come from within." Leaf poultices were recommended, though they were seldom observed in use. The leaf of the leguminous ***kupang*** shrub *(Cassia alata)* was cited by Gimlette and Thomson (1939) as having antiparasitic effects on ringworm.

A ***bomoh*** specializing in treatment of toothache applied to the victim's cheek a solution of the calcium compound (burnt seashells) that is chewed in the betel quid. Other villagers made their own leaf poultices for aching teeth, asked the investigator for aspirin, or applied medicated adhesive plasters available in local shops to the painful jaw.

MALAY TREATMENT OF WESTERN-PERCEIVED DISORDERS

Despite a long list of Malay-defined illnesses, of which the foregoing are a selection, these Malays correctly recognized certain diseases familiar to westerners. These included ***puru*** (yaws), which they thought came from hell, ***batuk kering*** or dry cough (tuberculosis) and ***campak*** (measles). The latter was sometimes confused with more generalized red rashes called ***penyakit awal.*** Villagers distinguished between "real" smallpox—***cacar betul***—and chickenpox—***cacar air,*** water blisters—and knew one could get "shots" (injections, *cucuk)* as a preventive against the former. They recognized nine different types of malaria ***(demam kura,*** literally "spleen fever"), including the hot and shivering phases, although their categories were based on the relative degree and type of fever accompanying the disease rather than on variations perceived in the condition itself. They were aware that the condition involved splenic enlargement; the ***bomoh*** massaged the abdomen with oil to help shrink the spleen.

Villagers knew that diabetes ***(kencing manis,*** sweet urine), obesity and high blood pressure ***(darah tinggi,*** "high blood") were public health problems. Although Gimlette and Thomson (1939) do not mention use of the following plants for these conditions, ***kampung*** people indicated that the ***jering*** *(Pithecolobium lobatum)* and ***petai*** *(Parkia speciosa)*, beans or pods from two trees of the mimosa family that smelled strongly of garlic and were taken in season as side dishes at meals, were effective treatment for diabetes (Fig. 2). Both legumes are diuretic. They contain volatile oils and probably alkaloids as well (Burkill 1966). They are worthy of further study of the compound or compounds responsible for their seeming pharmacologic properties.

FIG. 2.—Bunches of pods of ***petai*** beans for sale in main market, Kota Baru, Kelantan, surrounding women on lower right.

MALAY PERCEPTIONS OF DIAGNOSES AND WESTERN MEDICINES

It is probable the East Coast Malay attitude toward illness and its treatment will change increasingly toward western diagnoses and medications with modernization, inevitable after recent institution of offshore oil production. At the time this research was conducted (1968-71), ***kampung*** people believed there were disorders the doctor could cure and others better handled by the ***bomoh. Kampung*** medicines might not always be swiftly efficacious, but the attention that accompanies treatment is well known to be palliative, even curative in some cases. Because they were chiefly plant parts, villagers saw Malay medicines as minimally harmful to an invalid, whereas doctor's pills, potions and shots were considered ***ubat panas,*** "hot" medications that could harm someone suffering from a "hot" illness such as fever or rash. Doctor's medicines, which to these Malays included over-the-counter cough drops, worm medicines, medically impregnated adhesive plasters, ***minyak angin*** ("wind oil," camphorated oil), gentian violet, and various kinds of tonics—all latter-day introductions—were nonetheless used quite freely, often without professional medical instructions to do so. It was important, however, in their minds, not to take any of these "hot" medications and ***kampung*** remedies at the same time, for the two different types of medicines would war inside, causing the indisposed consumer to become ***mabuk***—drunken or dizzy. The kinds of foods eaten while taking doctor's medications also needed to be chosen with care, as has been detailed in an earlier paper (Wilson 1981). Different ***kampung*** treatments could be taken together without fear of consequences, even though some—barks especially—were "hot" while leaves were "cold." The "cold" types of village remedies, it was indicated, were best for *bisa* (toxic) illnesses, chills, fevers, headaches, or dizziness.

The villagers as well as the ***bomoh*** and ***bidan*** knew some conditions were better treated by scientific medicine and its practitioners. For example, severe cases of malaria and complications of pregnancy were better cared for and more readily resolved by western-trained health professionals. Both ***bomoh*** and ***bidan*** were prompt to refer serious illnesses or injuries to ***ospital*** (hospital). Along with the ***kampung*** people, however, these traditional healers felt that some of their treatments, such as frequent massaging instead of immobilization of broken limbs, were better than those of the doctor. Western medical science now recognizes that this traditional treatment of injured bones speeds recovery.

A mix of traditional ***kampung*** treatments and "modern" store-bought medications was emerging in this part of Malaya by the 1970s. Traveling salesmen of various nostrums, ancient and modern, Malay, Indian and Chinese, appeared at weekly markets or public celebrations, touting their remedies like patent medicine men in the U.S. in time gone by (Wilson 1981). These purveyors of potions used microphones and amplifiers along with entertainment to capture an audience. One of the more recent introductions was ***panisilin*** (penicillin), which could be bought in local shops in the 1970s, and was taken without prescription as a universal cure-all. Other western treatment favored among Malays was "shots." People believed that a shot existed for every ill, and should be sought, if ***kampung*** treatment failed, from the doctor or government clinic.

The pragmatism of these Malays in choosing medical treatment is further and perhaps best shown by two personal observations. A village school teacher came home from Kuala Lumpur where he was taking courses, with a number of remedies, wood chips, herbs and powders, that he had bought for his family's use from a Chinese apothecary. When my premedical colleague and I interviewed the senior ***bomoh*** we asked him if Chinese medicines were good or not. He said, "yes, they are good, too," indicating that they were commendable according to Islamic religion, and their preparation was the known trade of their formulators. "Can Malay people use Chinese medicines?" we asked. "Certainly," he replied, "there is nothing wrong (with them), they can use (them) all." In medical usage, if not politically, these fishing peasants were multiethnic as well as pragmatic.

FOODSTUFFS AS MEDICINES

A number of herbs and spices with which western cooks are familiar were recommended by ***bomoh*** and villagers for their curative powers. Anise and cumin ***(jintan manis*** and ***jintan puteh,*** *Pimpinella anisum, Cuminum cyminum),* ginger ***(haliah,*** *Zingiber officinale),* cinnamon ***(kayu manis,*** *Cinnamomum zeylanicum)* and similar "hot" spices served as tonics. Liquid made from cinnamon bark was smeared on cuts. ***Selaseh*** or ***kemangi*** *(Ocimum basilicum, O. sanctum),* basil, was used as a decoction or in poultices, as was ***medang,*** laurel leaves.

Some vegetable foods were also used medicinally. Sweet shoots ***(cekur manis,*** *Sauropus androgynus),* manioc leaf, and swamp cabbage or water convolvulus ***(kangkung,*** *Ipomoea aquatica),* taken as meal vegetables, were also used in plasters and potions, as was fragrant pandanus ***(pandan wangi,*** *Pandanus tectorius),* bean leaf, hibiscus leaf ***(bunga raya,*** *Hibiscus rosa-sinensis)* and the leaf of the ***gelam*** (paper-bark tree, *Melaleuca leucadendron).* Eating garlic was recommended for stomach ache, and for joint pain when mixed with bean sprouts and bamboo shoots. Ginger taken internally was considered good for fatigue. Fenugreek ***(halva,*** *Trigonella foenumgraecum),* boiled as a drink, or a drink made from seven young cashew leaves plus some of the bark, were recommended for upset stomach. The ***kemudu*** or ***mengkudu*** *(Morinda elliptica)* was considered good for conditions requiring "hot" medication, and the leaf of the aromatic ***tanjun*** *(Mimusops elongi)* tree was said to be good for headache.

Not all inhabitants of the village used traditional remedies from plants. One plant food that was a universal panacea was the ubiquitous staple, rice. It was always urged on a sick person as a conveyer of strength and restorer of energy and well-being. Soft-boiled rice actually is soothing to an upset digestive system; this simple carbohydrate is more readily digested in illness than other foods available to Malays. Rice powder (from pounded raw grains) in water was used as an antidote called ***tepung tawar,*** as magic in ceremonies and in some of the medical treatments outlined above.

CONCLUSION

Although neither the ***bomoh*** nor I was able to name or identify all the species of trees, shrubs and herbs from which the traditional healers of this village obtained medicinals, plants and their parts were viable items of the pharmacopoeia of this peasant fishing village. This research, which was neither intensive nor extensive, illustrates the pragmatic approach of traditional peoples to medical problems and their cures. They sought the most efficacious remedies. If one did not work, they tried another, crossing ethnic and cultural boundaries to do so. Thus their inclusion of Chinese remedies as cognates of their own village medicines was more surprising to me than to them. How long this eclectic use of the medications of another population group has been going on may be a matter of interest to some historian of Chinese herbal medicine.

Since the research reported here was conducted, more modern ways have come to the East Coast in the wake of proliferating economic and technologic change accompanying successful offshore oil production. The senior ***bomoh,*** who was in his 80s when he was interviewed in 1971, has died, as have two of the younger men whose data have been used in this report. The fourth no longer practices. The two ***bidan kampung*** have retired. There are still ***bomoh*** in the region and the village, but their help is sought by villagers only for conditions the western-trained clinic, hospital and medical practitioners are not able to alleviate. Malaysian government health education has more successfully persuaded many ***kampung*** people to seek "scientific" medical care for more of their ills.

There is need to analyze further some of the traditional medicinal treatments used by peoples in emergent societies such as this one before their village-perceived efficacy is forgotten, or the ways in which they have been used disappear from memory.

ACKNOWLEDGMENTS

The research on which this report is based was supported by National Institutes of Health Grant AI 10051 to the Department of Epidemiology and International Health, University of California, San Francisco, through the U.C. International Center for Medical Research (UC-ICMR) at the Institute for Medical Research, Kuala Lumpur, Malaysia, and National Institutes of Health Grants 35,001-3 and AM-19152 to the investigator.

The assistance of D. Terence Iddins, M.D., in collecting information from the ***bomoh*** is gratefully acknowledged.

LITERATURE CITED

BROWN, C.C. 1935. Trengganu Malay, J. Malayan Br., Roy. Asiatic Soc. XIII, part III.

BURKILL, I.H. 1966. A dictionary of the economic products of the Malay Peninsula, Kuala Lumpur: Ministry of Agriculture and Cooperatives.

BURLING, ROBBINS. 1965. Hill farms and padi fields. Life in mainland Southeast Asia, Prentice-Hall, Englewood Cliffs, NJ.

COEDES, GEORGE. 1968. The Indianized states of Southeast Asia. (Walter F. Vella, ed., translated by Susan Brown Cowing). Univ. Hawaii Press, Honolulu.

GIMLETTE, JOHN D. 1915. Malay poisons and charm cures, Oxford Univ. Press, Kuala Lumpur (reprinted, Oxford-in-Asia, 1971).

__________, and H.W. THOMSON. 1939. A dictionary of Malayan medicine, Oxford Univ. Press, Kuala Lumpur (reprinted, Oxford-in-Asia, 1971).

HOLTTUM, R.E. 1954. Plant life in Malaya, Longmans, Green and Co., London.

JOHNSON, ANNE. 1965. Malayan botany. Eastern Univ. Press, Singapore.

McKAY, DAVID A. 1971. Food, illness and folk medicine. Insights from Ulu Trengganu, West Malaysia. Ecol. Food Nutr. 1: 67-72.

SKEAT, WALTER WILLIAM. 1900. Malay magic: being an introduction to the folklore and religion of the Malay Peninsula, Macmillan and Co., London.

SYED MOHD. NAGUIB AL-ATTAS. 1970. The correct date of the Trengganu inscription, Muzium Negara, Kuala Lumpur.

WILKINSON, R.J. 1969. A Malay-English dictionary (ed. 9, revised and enlarged by A.E. Coope), Macmillan and Co., Kuala Lumpur.

WILSON, CHRISTINE S. 1970. Food beliefs and practices of Malay fishermen: an ethnographic study of diet on the East Coast of Malaya. Unpubl. Ph.D. dissert. (Nutr.) Univ. California, Berkeley.

__________, J.C. WHITE, K.S. LAU, Y.H. CHONG and D.A. McKAY. 1970. Relations of food attitudes to nutrient status in a Malay fishing village. Fed. Proc. 29: 821.

__________. 1981. Food in a medical system: prescriptions and proscriptions in health and illness among Malays, pp. 391-400, *in* Food in perspective (Alexander Fenton and Trefor M. Owen, eds.), John Donald, Edinburgh.

WINSTEDT, RICHARD. 1965. An unabridged Malay-English dictionary (ed. 6), Marican and Sons, Kuala Lumpur.

__________. 1969. A history of classical Malay literature, Oxford Univ. Press, Kuala Lumpur.

NOTES

[1]Paper presented to the Symposium: Chinese Nutritional and Herbal Medicine, 7th Annual Ethnobiology Conference, Seattle, 17 April 1984.

[2]Plant specimens were identified with the aid of the following botanical publications: Holttum (1954), Johnson (1965), and Burkill (1966).

[3]In August 1975 Indonesia and Malaysia agreed officially to adopt the same spelling for their common language. As was the case before this agreement, words are spelled phonetically. By the newer accord the letter "c" represents the sound formerly written as "ch" in Malaysia and "tj" in Indonesia. The hard "k" sound of the letter "c" is represented by "k" in the binational orthography.

J. Ethnobiol. 5(2):135-141 Winter 1985

CONTRIBUTIONS OF F.W. PUTNAM (1839-1915) TO ARCHAEOETHNOBIOLOGY

RALPH W. DEXTER
Department of Biological Sciences
Kent State University
Kent, Ohio 44242

ABSTRACT.—Frederic Ward Putnam was trained by Louis Agassiz between 1856-64 at the Museum of Comparative Zoology, Harvard University, where he worked as an assistant in charge of fishes. After serving at several institutions located at his native Salem, Massachusetts, he returned to Harvard University as Curator of the Peabody Museum of American Archaeology and Ethnology in 1875 and remained there for the rest of his life. In addition to developing that museum he was instrumental in developing anthropology at the Field Museum of Natural History in Chicago, the American Museum of Natural History in New York, and at the University of California in Berkeley. He specialized in american archaeology and published especially studies on shell-heaps of New England; shell-heaps of California; ash pits, Indian mounds, and cemeteries of the Mississippi Valley; stone graves in Tennessee; and caves of Kentucky. Although he was not specifically an archaeoethnobiologist, he contributed in many ways to the development of that field.

INTRODUCTION

Frederic Ward Putnam was born in Salem, Massachusetts, in 1839. As a young man his interest in nature was developed by his father and Dr. Henry Wheatland at the Essex Institute in Salem where he assisted Dr. Wheatland at the museum of the Institute. Putnam later studied under Louis Agassiz (1856-64) at the Museum of Comparative Zoology, Harvard University, and eventually was appointed assistant in charge of fishes. He was simultaneously Curator of Vertebrates at the Essex Institute, and served as the director between 1864-70. During part of that time (1867-69) he was also superintendent of the museum of the East India Marine society in Salem. In 1866, when George Peabody founded the Peabody Academy of Science (now the Peabody Museum of Salem), Putnam became its first Director and Curator of Vertebrates (1867-74). This new institution incorporated the museum of the East India Marine Society (Whitehill 1949). With his colleagues he was founder of the *American Naturalist* and the American Society of Naturalists.

While attending the Montreal meetings of the American Association for the Advancement of Science in 1857, Putnam discovered shell-heaps at Mount Royale Park which stimulated his interest in archaeology and eventually led him to turn from zoology to archaeology as a career. He became Curator at the Peabody Museum of American Archaeology and Ethnology at Harvard University in 1875, and remained until his retirement in 1909. He then served as Honorary Director until his death in 1915. From a small nucleus of miscellaneous collections in Boylston Hall, he developed one of the leading museums of anthropology in the country, and greatly influenced the development of departments and museums of anthropology at the Field Museum of Natural History in Chicago, the American Museum of Natural History in New York, and the University of California in Berkeley (Dexter 1966a,b).

CONTRIBUTIONS TO ARCHAEOETHNOBIOLOGY

Among other things, Putnam's published studies illustrate the utilization of biological resources by the North American aborigines. In addition to compiling data, he collected and preserved archaeological specimens and animal remains still in use for research at the Peabody Museum of Harvard University (pers. comm., Dr. Stephen Williams). Putnam's practice of saving biological specimens from archaeological sites, learned from his training in zoology under Agassiz, was one of his greatest contributions to a discipline not yet formalized. As a zoologist-turned-archaeologist, his viewpoint considered man as just another species, to be studied as a part of an over-all view of natural history. Two of Putnam's former associates paid tribute to this philosophy: Boas (1915) pointed out that Putnam applied the methods of natural history in all of his work, and Kroeber (1915:713) wrote that "He was early and remained to the last, a natural historian."

Castetter (1944) regarded ethnobiology as the relationship of primitive man to the total biological environment. Many define archaeoethnobiology as the study of relationships of living organisms to, and their utilization by, prehistoric cultures (i.e., aborigines). Selected portions of some of the reports and papers by Putnam cited here have been reprinted by Phillips (1973) and Williams (1973). No attempt will be made here to reiterate the details given in the various publications, which can be consulted for such information. The present paper indicates only the scope of organisms important in the life of certain groups of non-industrial men in North America. Putnam did not seek out biological artifacts exclusively; in one sense they were often a by-product of his investigations, but they always indicated the relation of man to nature.

Following is a brief summary of Putnam's contributions with a reasonably complete bibliography of his works pertaining to archaeoethnobiology.

A. Shell-heaps of New England (Putnam 1869a,b; 1871; 1872; 1882a; 1883a).

Putnam's interest in the shell-heaps of New England was stimulated by Dr. Jeffries Wyman, one of his teachers at Harvard (Wyman, 1868). Among major items studied were:

1. Food mollusks-large quantities of the bivalves common clam, hen clam, quahog, oyster, and scallop (quahog, oyster, and scallop are now gone from many areas where they were formerly found); and the gastropods, moon snail and whelk.
2. Food vertebrates-fishes (especially monkfish, cod fish, flounder, and sturgeon); turtles; birds (ducks and herons); mammals (Virginia deer, moose, black bear, fox, skunk, otter, beaver, and seal).
3. Implements of sharpened bone, bone awls, and fish spear heads from bone.
4. Clam shells as binder in clay pottery.
5. Shells for ornaments (some pierced).
6. Human bones ("as if for stew pot")—may indicate cannibalism—(Putnam 1882a).

Putnam's work on the north Atlantic coast was soon followed by that of Baird (1882), Matthew (1884), Bailey (1887), Ganong (1889) and Loomis and Young (1912), all of whom gave lists of marine life utilized by the prehistoric natives. General reviews of the culture of the northeastern Indian hunters have been published by Cooper (1946) and Flannery (1946).

B. Shell-heaps of California and Pueblos of Arizona and New Mexico (Putnam et al. 1879).

As part of the Wheeler U.S. Geographical Survey (Putnam et al., 1879), Putnam reported on the biological content of shell-heaps in southern California. In later years the study was followed up by Nelson (1909), Kroeber (1911), and Gifford (1916).

1. Shell-heaps of the coast and islands of Southern California.
   a. Fish hooks from abalone shells.

b. Needles, pins, awls, fish hooks, harpoon points, knives, swords, daggers and ornaments from bone.

c. Harpoon points for fishing and wedge-shaped implements from ribs of cetaceans.

d. Polishing bones and swords from lower jaw of porpoise.

e. Wooden swords and handles with inlay of abalone shell.

f. Whistles from tibia of deer and bones of birds.

g. Shell beads for ornaments on implements, and olive shells strung for beads.

h. Pendants made from scallop shells, the columella of snail shells, and the serrated lips of *Cyprea* (cowrie) shells.

i. Cups for holding paint made from small abalone shells and several species of bivalves and larger limpet shells.

j. Sharks teeth, cetacean teeth, rodent teeth as decorative pendants (possibly also, claws of bears and panthers).

k. Fabrics and rope from *Zostera* (eelgrass).

Putnam's service in developing anthropology in California has been outlined by Dexter (1966c), and his role in the Calaveras Skull controversy will soon be published (Dexter 1986).

2. Pueblos of Arizona and New Mexico

a. Cloth and nets from yucca fiber.

b. Twine and rope from twisted bark fiber (inner bark of trees).

c. Basket work from long stems of *Juncus* (sedges).

d. Brushes from soap-root (for washing hair).

Fewkes (1896a,b; 1904), a former colleague of Putnam, made a study of ethnobiology at the Tusayan pueblos in Arizona.

C. Ash pits (Ohio explorations) (Putnam 1882b; 1885; 1888).

1. Carbonized maize—a major food item.
2. Burnt seeds, nuts, and acorns, and pieces of grass matting.
3. Shells of fresh-water clams for food, many with holes cut in center to make a hoe.
4. Bones of fishes, reptiles, birds and mammals used as food. Those of deer, elk (wapiti), and bear generally broken (to obtain marrow?).
5. Fish hooks and harpoon points from animal bones.
6. Implements made from animal bones and the antlers of deer and elk.
7. Awls, beads, and whistles (bird-call whistles), from hollow bones of birds.

D. Indian mounds of Mississippi Valley (Putnam 1872b; 1874a; 1880a; 1883c; 1905; Metz and Putnam 1886).

Indian skulls from mounds at Dubuque, Iowa, were both short and high, and long and flat, suggesting a wide distribution and migration of both types. Putnam believed a movement had taken place from Mexico northward, and then returned to the south.

From a shell-bed at Rock Island, Illinois, a human skull was found with shells of freshwater mussels, a freshwater snail *(Melania subsolida)*, and several species of land snails. Putnam regarded this deposit as, "Ancient Indian" and not "Mount Builder" since the latter did not make shell-beds.

From mounds in the Cumberland Valley of Tennessee were found shell beads and pearls interpreted as toys in the graves of children.

From Ohio mounds:

1. Ornaments of shell including sea shells.

2. Shell beads including a marine snail *(Marginella* sp.) with the apex cut off for stringing, and pearl beads from river mussels.
3. River clams (mussels) for food.
4. Split animal bones—mostly deer and bear (food).
5. Implements of bone including needles and awls.
6. Bear's teeth perforated for ornaments, some with pearls inserted.

Putnam's contributions to Ohio archaeology have been summarized (Dexter 1965), and the Putnam-Metz correspondence on mound explorations in Ohio has recently been published (Dexter 1982).

Further studies on the utilization of animal life (especially the mollusks) by prehistoric natives of the Mississippi Valley are included in works by Read (1903), Baker (1930, 1931, 1941), Morrison (1942), and Willoughby and Hooton (1975). A general review of the field of ethnoconchology has been published by Lambert (1960).

On a water bottle collected at Moundville, Alabama, there was a design identified by Witmer Stone as the Ivory-billed Woodpecker (Putnam 1905), now virtually extinct.

E. Stone Graves in Tennessee (Putnam 1878; 1880a,b).

With skeletal remains of "The Stone Grave People of Tennessee" were found:

1. Marine shells (including olive shells) from the Gulf Coast (trade goods).
2. Shell beads and ornaments; pearls.
3. Freshwater mussel shells (including a spoon made from one).
4. Animals bones—especially deer and birds.
5. Bone implements, needles, etc.; awls from deer antlers.
6. Turtle shells (for rattles?). (See Dexter 1966d for an account of Putnam's work in herpetology).
7. Burnt corncobs and charred fragments of matting.
8. Pottery of clay mixed with broken shells.

F. Cemeteries (Putnam 1874b; 1882b; 1883b; 1885; 1887; 1888).

1. Essex County, Massachusetts.
   a. Shell beads (Wampum). For shells used as money, see Ingersoll (1883) and Sterns (1889).
   b. Fish spears cut from bone (for use in future life).
2. Little Miami Valley, Ohio.
   a. Shell ornaments.
   b. Perforated clam shells (hoes?).
   c. Animal bones (food).
   d. Bone implements, including fish hooks from leg bones of deer.
   e. "Salamander pots" (head of salamander modeled on edge or lip of vessel).

G. Caves (Putnam 1875a,b,c; Putnam et al. 1879).

1. Mammoth Cave of Kentucky.

   Packard and Putnam (1879) published an account of "The Mammoth Cave and its Inhabitants," but archaeology was not included. Dexter (1985) recently described Putnam's scientific work in Mammoth Cave, including archaeology.
2. Salt Cave (near Mammoth Cave, Kentucky).
   a. Bundles of fagots tied with twisted bark (burned for light or firewood?).
   b. Reed torches.
   c. Small fagots of inner bark; cloth of inner bark.

d. Sandals of braided, twisted leaves of rushes and cattails.

e. Fragments of large gourds.

f. Wooden dish.

g. River "muscles" (Putnam 1875a)—one with hole (hoe?). Putnam used the old spelling "muscle". Dexter (1961, 1967) has traced the history and use of the word "muscle" formerly used in place of the more familiar spelling "mussel".

h. Feathers (turkey?).

H. Surface finds (Putnam 1872c; 1873).

1. Turkey Hill, Ipswich, Massachusetts. Found stone ornament of soft slate (6.5 cm) representing a fish. Probably "worn as a medicine" (ie., votive), or to designate wearer "was a noted fisherman."

2. Seabrook, New Hampshire. Found was a carved stone representing a porpoise or white whale (Beluga Whale), made of sienitic rock (25 x 5.5 cm) used as an ornament or totem.

CONCLUSION

Although not specifically an ethnobiologist, F.W. Putnam, a zoologist-turned archaeologist, contributed in many ways to the study of archaeoethnobiology. With his training in zoolology under Louis Agassiz, he studied man as another animal and was much concerned with man's utilizatin of biological resources.

LITERATURE CITED

BAILEY, L.W. 1887. On the relics of the stone age in New Brunswick. Bull. Nat. Hist. Soc. of New Brunswick 6:3-16.

BAIRD, SPENCER F. 1882. Notes on certain shell mounds on the coast of New Brunswick and of New England. Proceed. U.S. Nat. Mus. (for 1881) 4:292-297.

BAKER, FRANK C. 1930. The use of animal life by the mound-building Indians of Illinois. Trans. Illinois. State Acad. Sci. 22:41-64.

———. 1931. Additional notes on animal life associated with the mound builders of Illinois. Trans. Illinois State Acad. Sci. 23:231-235.

———. 1941. A study in ethnology of the prehistoric Indians of Illinois. Part 2. Contributions to the archaeology of the Illinois River Valley. Trans. Amer. Philos. Soc. 32:51-78.

BOAS, FRANZ. 1915. Frederic Ward Putnam. Science 42:330-332.

CASTETTER, EDWARD F. 1944. The domain of ethnobiology. Amer. Nat. 78:158-170.

COOPER, JOHN M. 1946. The culture of the northeastern Indian hunters: a reconstructive interpretation. Pp. 272-306 *In* Man in northeastern North America. Johnson, Frederick (ed.). Papers, Robert S. Peabody Found. for Arch. Vol. 3.

DEXTER, RALPH W. 1961. Mussel Shoals vs. Muscle Shoals. Sterkiana 4:29-31.

———. 1965. Contributions of Frederic Ward Putnam to Ohio archaeology. Ohio J. Sci. 65:110-117.

———. 1966a. Frederic Ward Putnam and the development of museums of natural history and anthropology in the United States. Curator 9:151-155.

———. 1966b. Frederic Ward Putnam's interests in natural history. Nature Study 20(3):1-2.

———. 1966c. Contributions of Frederic Ward Putnam to the development of anthropology in California. Sci. Ed. 50:314-318.

———. 1966d. Some herpetological notes and correspondence of Frederic Ward Putnam. J. Ohio Herp. Soc. 5:109-114.

———. 1967. Addenda on mussel vs. muscle. Sterkiana 27:1-2.

———. 1982. The Putnam-Metz correspondence on mound explorations in Ohio. Ohio Arch. 32(4):24-28.

LITERATURE CITED (Continued)

————. 1985. F.W. Putnam's scientific studies at Mammoth Cave (1871-1881). NSS (Nat. Speleo. Soc.) Bull. 46:10-14.

————. 1986. Historical aspects of the Calaveras skull controversy. Amer. Antiquity (in press).

FEWKES, J. WALTER. 1896a. A contribution to ethnobotany. Amer. Anthrop. 9:14-21.

————. 1896b. Pacific coast shells from prehistoric Tusayan pueblos. Amer. Anthrop. 9:359-367.

————. 1904. Two summers work in pueblo ruins. Bur. Amer. Ethnol. 22nd Annu. Rept. (for 1900-01):5-195.

FLANNERY, REGINA. 1946. The culture of the northeastern Indian hunters: a descriptive survey. Pp. 262-305 *In* Man in northeastern North America. Johnson, Frederick (ed.). Papers, Robert S. Peabody Found. for Arch. Vol. 3.

GANONG, W.F. 1889. The economic Mollusca of Acadia. Bull. Nat. Hist. Soc. of New Brunswick 8:3-116.

GIFFORD, EDWARD W. 1916. Composition of California shellmounds. Univ. California Publ. in Amer. Arch. and Ethnol. 12:1-29.

INGENSALL, ERNEST. 1883. Wampum and its history. Amer. Nat. 17:467-479.

KROEBER, ALFRED L. 1911. Shell mounds at San Francisco and San Mateo. Records of the Past 10:227-228.

————. 1915. Frederic Ward Putnam. Amer. Anthrop. 17:712-718.

LAMBERT, R.J., JR. 1960. Review of the literature of ethno-conchology pertinent to archaeology. Sterkiana 2:1-8.

LOOMIS, F.B. and D.B. YOUNG. 1912. On the shell heaps of Maine. Amer. Jour. Sci. 34:17-42.

MATTHEW, G.F. 1884. Discoveries at a village of the stone age at Bocabec, New Brunswick. Bull. Nat. Hist. Soc. of New Brunswick 1:5-29.

METZ, CHARLES L. and F.W. PUTNAM. 1886. Explorations in Ohio. The Marriott mound and its contents. 18th Annu. Rept., Peabody Mus. Amer. Arch. Ethnol., pp. 449-466.

MORRISON, JOSEPH P.E. 1942. Preliminary report on mollusks found in the shell mounds of the Pickwick Landing Basin in the Tennessee River Valley. Bur. Amer. Ethnol., Bull. 129:339-392.

NELSON, N.C. 1909. Shell mounds of the San Francisco Bay region. Univ. California Publ. Amer. Arch. and Ethnnol. 7:309-356.

PACKARD, ALPHEUS S. and F.W. PUTNAM. 1879. The Mammoth Cave and its inhabitants. Salem Press, Salem, Mass.

PHILLIPS, PHILIP (ed.). 1973. Antiquities of the new world. Early explorations in archaeology. Vol. 8. The archaeology reports of Frederic Ward Putnam (from the Annual Repts. of the Peabody Museum of Amer. Arch. Ethnol., Cambridge, 1875-1903) AMS Press, Inc., N.Y.

PUTNAM, FREDERIC W. 1869a. On shellheaps in Essex County, Massachusetts. Bull. Essex Insti. 1:123.

————. 1869b. On skulls of several species of bears . . . found in a shellheap on Goose Island, Massachusetts. Bull. Essex Insti. 1:138.

————. 1871. Indian relics from Beverly. Bull. Essex Insti. 3:123-125.

————. 1872a. Indian shell heaps. Bull. Essex Insti. 4:122-123.

————. 1872b. Note on ancient races of America. Proceed. Boston Soc. Nat. Hist. 15:228-229.

————. 1872c. Description of an ancient Indian carving found in Ipswich. Bull. Essex Insti. 4:156-158.

————. 1873. On stone implements and a carved stone representing a cetacean found at Seabrook, N.H. Bull. Essex Insti. 5:111-114.

————. 1874a. Notice of Indian skull from shellbed on Rock Island, Illinois. Bull. Essex Insti. 6:70-72.

————. 1874b. Indian remains from Essex County, Massachusetts. Bull. Essex Insti. 6:17-19.

————. 1875a. Archaeological explorations in Indiana and Kentucky. Amer. Nat. 9:410-415.

————. 1875b. Archaeological researches in Kentucky. Bull. Essex Insti. 7:2-9.

————. 1875c. Archaeological researches in Kentucky and Indiana, with description of Salt Cave. Proceed. Boston Soc. Nat. Hist. 17:314-332.

————. 1878. Archaeological explorations in Tennessee. Bull. Essex Insti. 10:72-85.

————. 1880a. Archaeological explorations in Tennessee. Proceed. Boston Soc. Nat. Hist. 20:331-333.

————. 1880b. Archaeological explorations

LITERATURE CITED (Continued)

in Tennessee. 11th Annu. Rept., Peabody Mus. Amer. Arch. Ethnol. 2:305-360.

_______. 1882a. On the Robinson collection from shellheap at Ipswich. Bull. Essex Insti. 14:161-163.

_______. 1882b. Archaeological explorations at Madisonville, Ohio. Proceed. Boston Soc. Nat. Hist. 21:216-222.

_______. 1883a. Shellheaps on the coast of Maine. Science 1:319.

_______. 1883b. The ancient cemetery at Madisonville, Ohio. Science 1:373-374.

_______. 1883c. Mound explorations in the Little Miami Valley, Ohio. Science 1: 496-497.

_______. 1885. Explorations of the Harness Mounds in the Scioto Valley, Ohio. 18th Annu. Rept., Peabody Mus. Amer. Arch. Ethnol. 3:223-227.

_______. 1887. The way bone fish-hooks were made in Little Miami Valley. 20th Annu. Rept., Peabody Mus. Amer. Arch. Ethnol. 3:581-586.

_______. 1888. Note on bone fish-hooks. Proceed. Boston Soc. Nat. Hist. 23:240.

_______. 1905. Bird design on water bottle from Moundville, Alabama. P. 138 *In* Moore, C.B. 1905. Certain aboriginal remains, Black Warrior River. J. Acad. Nat. Sci. Phila. Vol. 13.

PUTNAM, FREDERIC W., et al. 1879. Reports upon archaeological and ethnological collections from vicinity of Santa Barbara, California, and from ruined pueblos of Arizona and New Mexico, and certain interior tribes. Rept. U.S. Geog. Survey West of the 100th meridian (Wheeler Survey). Vol. 7, Archaeology, 479 pp.

READ, MATTHEW C. 1903. Archaeology of Ohio. Western Reserve Hist. Soc., Cleveland, Ohio.

STEARNS, ROBERT E.C. 1889. Ethno-conchology: a study of primitive money. U.S. Nat. Mus., Annu. Rept. for 1886-87: 297-334.

WHITEHILL, WALTER M. 1949. The East India Marine Society and the Peabody Museum of Salem. A sesquicentennial history. Anthoensen Press, Portland, Maine.

WILLIAMS, STEPHEN (ed.). 1973. Antiquities of the New World. Early explorations in archaeology. Vol. 5. The selected Archaeological papers of Frederic Ward Putnum, 1855-1915. AMS Press, Inc., New York.

WYMAN, JEFFRIES. 1868. An account of some Kjoekken-moeddings, or shell-heaps, in Maine and Massachusetts. Amer. Nat. 1:561-584.

J. Ethnobiol. 5(2):143-157 Winter 1985

FOOD AND THE EARLY HISTORY OF CULTIVATION

I. S. FARRINGTON
Department of Prehistory & Anthropology
Australian National University
Canberra A.C.T. 2601, Australia

and

DR. JAMES URRY
Department of Anthropology
Victoria University of Wellington
Wellington, New Zealand

ABSTRACT.—A cultural argument is proposed to explain the origins and development of cultivation in different areas of the world. It is suggested that culturally valued foodstuffs which reflected cultural categories of edibility, taste and other forms of sensory appeal may have had more of an influence on the domestication of plants than the search for staple crops. The role of food processing, cooking and the exchange of foodstuffs in the development of cultivation and the diffusion of plants and animals is examined. Then ideas are examined against the existing evidence of cultivation from archaeological sites in S.W. Asia, S.E. Asia and E. Asia and Middle and South America.

INTRODUCTION

The origins of agriculture remain one of the central issues of prehistory. The problems of where, when, how, and particularly why agriculture first developed have been the subject of much research, discussion and debate (e.g. Struever 1971; Hutchinson 1975; Reed 1977; etc.). A combination of archaeological and botanical techniques, such as the recording and mapping of crop plant diversity and related wild species as well as research into crop plant genetics, have produced general answers to the first two questions, i.e., where and when, but the other problems (how and why), remain unanswered. This is not to deny that many hypotheses to these problems have been put forward, but none have received unqualified approval. The aim of this paper is to add to these hypotheses by providing an alternative explanation, and in doing so to widen the field of discussion on this central issue.

DEFINITIONS AND HYPOTHESES

There is some confusion in the literature concerning the use of the terms agriculture, horticulture, cultivation and domestication. By "cultivation" we mean the deliberate intervention by humans into the breeding cycle of selected plants through a sequence of intentional acts and techniques such as those involved in the preparation of fields, the husbanding of crops and the selection of seed or root stock. Such deliberate acts vary in their form and complexity but we suggest that plants, tilling, harvesting and the selecting of seed or root crop for future use are the basic attributes of a subsistence system known as cultivation. Horticulture is often used as if synonymous with cultivation, and both terms are regarded as a less intensive form of agriculture. We consider horticulture and agriculture should be regarded as opposite poles of a continuum of cultivation systems, involving differences in scale of operation and in crop diversity. In general, horticultural systems are small scale, garden systems which involve a wide range of crop plants from herb to tree species each represented by only a few individuals. Agricultural systems are larger scale systems of cultivation with extensive crop areas often divided into fields on which are cultivated a limited range of species each in large quantities. Agriculture is often equated with production of staple foodstuffs though, as will be seen, this need not always be the case and what constitutes a staple is often difficult to establish.

Although, in the literature, domestication is often used synonymously with agriculture, we wish to restrict the term to a set of morphological and/or genetic traits which distinguish selected crop plants from their wild ancestors. It is assumed that under the process of human selection, isolation and protection plant species will undergo change. Archaeological evidence and botanical experimentation suggest that the process of domestication of a plant to the point where it can be easily recognized involves a considerable period of time. The length of time varies between species but may take, hundreds, and in many cases, thousands of years for such changes to occur. It is often difficult to establish a baseline from which to measure changes, least of all to gauge the rate of change, and the natural variation of wild species is often poorly understood. However, it is assumed that cultivation preceded major changes in plant species and thus our ability to recognize domestication.[1]

A staple crop is one which provides the carbohydrate bulk for a population for most of a year. The archaeological identification of a staple remains problematic. The discovery of large quantities of the remains of a single species is often assumed to establish the existence of a staple but factors such as differential preservation because of the nature of the plant material, how it was processed, consumed and discarded all contribute to complicate such interpretations. The consideration of plant remains in the reconstruction of the range and quantities of plants cultivated at any one site must be treated with caution, as Hubbard (1975) has recently noted with regard to the changing staples of the Greek Neolithic. However, large numbers of sites in the same region which regularly show high frequencies of certain types of plant remains, can, in certain circumstances, be taken as evidence for the existence of a staple (eg., the wheats and barleys of the late Neolithic in Southwest Asia and rice in the Southeast Asian Neolithic).

Recent approaches to the question of how and why cultivation first developed have followed two general models, the deterministic and the stochastic. Deterministic models attempt to relate change in subsistence to stresses caused by environmental change, (particularly climatic change) and/or to population pressure. In such models people were forced to adopt cultivation to survive or to maintain and develop certain lifestyles. Stochastic models explore the range of subsistence strategies open to hunter/gatherers within particular environments by correlating the ecological, demographic and social factors which may have encouraged people to change their mode of subsistence. The latter models have mainly focused on sub-tropical regions where many of the world's crop plants originated and which are areas of localized environmental diversity which provided ideal situations for the development of cultivation.

These models present major problems as total explanations for the origin of cultivation. Deterministic models assume that people are largely controlled by external forces and that stress occurs irrespective of social and economic factors. Ethnographic research among recent or contemporary hunter/gathering societies suggests that few lead a precarious existence or would be subject to stress in even the most severe circumstances envisaged by those archaeologists who proposed deterministic models. Binford (1968) has clearly stated the deficiencies of such models and raised another issue when he noted (1968:327) that the problem is "not why agricultural and food-storage techniques were not developed everywhere, but why they were developed at all." Stochastic models, with their broader approach to the issues, provide a better explanation but they remain rooted in the interplay between environment, population and energetics and rarely invoke cultural factors as part of their explanation.

Both deterministic and stochastic models, as well as the archaeological and much of the botanical research devoted to their development and proof, have tended to concentrate on a narrow range of what are assumed to be important staple crops. However, there are clear signs from the prehistoric record of many parts of the world that the exploitation, adaptation and diffusion of staple crops was preceded by the cultivation of a wide variety of other plants. The approach, which will be developed in this paper, is that the cultivation of these plants should be considered in terms of their cultural value to societies existing in the past, rather than to their more essential utilitarian role in subsistence activities. Crucial among these cultural values is the importance of crop plants as food in a cultural sense, rather than as food in terms of sustenance.

THE RARE AND THE RELISHED

In all cultures certain objects are more esteemed than others and such prized items are endowed with high cultural value. The concept "value" is culturally specific and can be based upon a number of quite disparate criteria which need not relate to the objects most obvious material or utilitarian value to us as outsiders. An object may be culturally valued because of specific properties considered to be inherent in it or because it is associated with other objects of equal or greater value, power, and influence. Valued objects obtain their status because they are sometimes in short supply within a particular environment (because of restricted location, seasonal variations, etc.), because demand for the object exceeds its supply, because this supply has been artificially restricted, or because the object is foreign to a particular cultural environment, i.e., it is an exotic.

Many objects can therefore become prized for a variety of reasons within cultural environments. They can also take many forms, possess more than one meaning, and fulfill numerous functions within a number of contexts. Four major categories can be generally defined, although there is often considerable overlap in their uses and all involve the possible exploitation of plants. These four categories are articles associated with material culture, decoration, medicine and finally food.[2] In terms of plant sources they include raw material for artifacts and other items of material culture (clothing, building, etc.), dyes and other colorings, cosmetics, aromatics, stimulants, medicaments and, of course, a number of herbs, spices and other flavorings associated with food.

In this paper we will be concerned particularly with food, not because we think that the food sources are more important than the others, but because we believe they do have particular relevance to the development of the cultivation of staple crops.

Food is itself a cultural category and involves those substances which a culture considers edible or in some way sustenance of health. Initial selection of any item from a given environment is heavily influenced by notions of edibility. The quantities selected and the amount of energy exerted in acquiring food depends upon notions of preference. Preference is not an open to free choice by individuals within cultures but selection is molded through cultural habits and socialization; even where certain substances are recognized as being consumable, they may be proscribed by certain cultures for a number of reasons. Such negative rules concerning the selection of foodstuffs are well known in the etnographic and historical literature (Douglas 1966, Tambiah 1969, etc.). Positive notions of preference for particular foodstuffs are often not related to concepts of nutritional worth (although they may be associated with indigenous concepts of health, "essentialness," wellbeing, etc.) but are related to a wide number of concepts of cultural value. A cursory glance at the ethnographic literature reveals that such preferences are based upon a wide range of factors. In terms of food the most important considerations are often taste, color, smell and texture—concepts associated with the senses. Other factors include the role of food in terms of its part in larger social and ritual activities, and whether or not such items comprise part of what are considered essential for a meal or to complete a particular dish.

Taste undoubtedly plays an extremely important role in the selection of foodstuffs. Although little information can be found on this subject in the ethnographic literature, there are numerous accounts from many cultures of the importance attributed to sweet items derived from such sources as honey, fruits and natural sugars and from salt and related flavorings. Peoples with quite different modes of subsistence appear to relish such delicacies and expend an inordinate amount of time, energy and sometimes wealth to secure supplies. It is also clear from the literature that while many of these items have been collected from wild sources, others have long been the subject of careful cultivation. Indeed it is often easy to forget today that many items which are in easy supply were once extremely rare and highly esteemed.

ETHNOGRAPHIC INFERENCE AND ARCHAEOLOGICAL EVIDENCE[3]

It has been argued that cultivation may have first begun on household rubbish dumps and in small permanent garden plots close to settlements and on such sites a great diversity of plant species flourished in a human-constructed and human-protected environment. Some of these plants may have been adventives or weeds or may have served special functions in the societies. In such locations plants species which were later to become major staples are found, although initially they may not have been important food sources. A number of authors have put forward such ideas, suggesting the humans, by creating such protected environments, accidently or deliberately began to interfere in the natural breeding cycle of plants (Anderson 1952; Hawkes 1969; Harris 1969, 1973). As such changes occured, it is argued, humans came to recognize the benefits of isolating, protecting and developing plant species under particular conditions and gradually varieties and/or new species were developed which can now be recognized as domesticates.

It is our argument that among these early, protected and carefully husbanded plants were those to which high cultural value was given. Ethnographic evidence (eg., Anderson 1952:138-9) reveals that garden plots often contain a mixture of herbaceous and woody plants and a high percentage of spices, flavorings, drugs and other medicaments, gums, oils, perfumes, industrial and ornamental species and highly prized tasty fruits and nuts. Even among people often regarded as non-cultivators, similar patterns can be discerned. Jones (1975) describes rubbish-heap exploitation among the Anbara Aborigines of Arnhem land in Australia. A native fruit tree *(Eugenia suborbicularis)* and the exotic watermelon are found respectively around wet and late dry season camps. The seeds of these plants are discarded where eaten, and while there is no formal technique of cultivation or protection, there is an awareness among the Anbara that the seeds will later germinate and supply fruits at these locations the following year. Watermelon seeds have also been carried to new camp sites to establish new colonies. Diane Bell has informed us (per. comm., 1980) that on central Australian outstations the only indigenous plant introduced into garden plots by Aborigines is the ***pituri*** *(Duboisia hopwoodii)*, a native tobacco which also acts as a stimulant. There is evidence to suggest that ***pituri*** was moved around the landscape prior to European contact and thus may be regarded as an ancient cultivar. Today most of the exotic plants grown on such outstations are mostly highly prized items, such as tomatoes and watermelons.

Archaeological evidence to support the idea that the first plants cultivated were those highly valued is quite equivocal. The causes for this are obvious. Firstly such plants are often those least likely to be preserved in archaeological contexts. Secondly, the research emphasis has often concentrated on the discovery and identification of staples and thus other plants have often been overlooked. However, published data from Southeast Asia, the Americas and perhaps from Southwest Asia indicate the presence of non-staples in the record and these, we suggest, are crucial in any consideration of the early history of cultivation.

Southeast Asia is the homeland of three of the world's staples, the greater yam *(Dioscorea alata)*, taro *(Colocasia esculenta)* and rice *(Oryza sativa)*. No significant archaeological remains of yam or taro have been recorded, but rice appears in Thailand about 6-5000 years ago (BP) and slightly earlier in India (Glover 1979). Plant remains from Spirit Cave in northwestern Thailand are the earliest so far found in southeast Asia, and are dated to between 11 and 8000 BP (Gorman 1970). These remains have been subject to much debate, their cultivated status is unclear because there is no sign of domestication and no obvious staple. The plants which were found include both forest species and leguminous annuals which were seed reproduced. These comprise foodstuffs as well as plants which nowadays are used as stimulants, condiments, oils, poisons and containers (the genera included *Canarium, Aleurites, Madhuca, Areca, Terminalia, Piper, Trapa, Cucumis, Lagenaria* and the family *Leguminoseae)*. None of these plants today represents a staple in Southeast Asian communities. However, contemporary local use of these species and the presence of both forest perennials and annual herbs in the deposits, suggest some form of concentrated exploitation of these sources in antiquity (Yen 1977). This material could be interpreted as supporting our argument for the selection of culturally valued products, but at present there is no clear evidence of cultivation at the site and therefore our argument here remains speculative.

Even though China is known as a region where the early domesticates include a wide range of nuts, spices and vegetables as well as oil-bearing plants, pulses, roots, tubers, fibres and cereals (Ho 1977), the evidence for early forms of cultivation in China is like that of Southeast Asia, extremely sparse. China, however, supplies ample evidence for food habits in antiquity which reveal great variety and sophistication from early times with considerable value being placed on a number of rare items, including exotics (Schafer 1963; Chang 1977). The extensive and very ancient Chinese pharmacopoeia should also not be forgotten.

The evidence from Mexico is clearer. The earliest recognizable domesticates have been dated to levels aged between 9-7000 BP in the Tehuacan Valley. These domesticates include the chili pepper *(Capsicum annuum)* and the avocado *(Persea americana)* as well as certain species of squash *(Cucurbita* spp.), bean *(Phaeseolus* spp.) and fruit trees, such as the cosahuico *(Sideroxylon cf. tempisque)* and chupandillo *(Cyrtocarpa procera)*. Again, none of these can be assumed to be a staple and there is a predominance of sweet tasting fruits, oily fruits and legumes, condiments and other plants with multiple uses. MacNeish (1967) suggests that the earliest forms of cultivation were garden systems such as barranca (canyon) and hydro-horticulture, and Harris (1973) has subsequently suggested that this evidence fits the dump heap/household garden theory.

In the Tehuacan Valley *Setaria* millets, amaranth and wild maize *(Zea mexicana)* were also exploited with these early domesticates but there is no indication that these plants were themselves domesticated before 7000 BP. Maize does not begin the process of domestication until after this date and large scale agriculture based upon maize as a staple does not begin until 4300-3500 BP. It is therefore significant that the first domesticates were non-staples, including perennial trees and annuals. The process of domestication can occur quite rapidly and accidentally in annuals, such as grasses, (Wilke *et al.* 1972). By contrast, the domestication of fruit trees may take several centuries, if not millennia because they require several years to bear fruit and cross-pollinate readily with wild individuals. Thus the domestication of maize and fruit trees may be regarded as separate processes of perception, selection and isolation.

The archaeological evidence for early cultivation in Southwest Asia does not immediately appear to support our hypothesis, perhaps because the literature has been dominated by study of the major domesticates—wheats and barleys along with legumes (peas, horse-bean, vetch, lentils and chick peas)—between 11 and 8000 BP, along with the problems associated with animal domestication. Deterministic models appear the most likely and most favored explanation for the origins of cultivation in this region. It is well known, however, that Southwest Asia was also the center of domestication of a large range of multi-purpose plants (Harlan 1975). If the evidence for early domestication from a number of sites in the region is carefully examined, the range and importance of many of these plants becomes apparent. Zohary and Spiegal-Raoy (1975) have noted that the earliest evidence for the domestication of major fruit and nut trees, including the grape, olive, fig, date, almond, pomegranate, sycamore fig, etc., occurs in protohistoric times (6000-5000 BP) in Southwest Asia, and that by the early Bronze Age they had become important in the economies of many settlements. To this list of plants must be added the walnut. The natural range of all these seed and clonally reproduced woody species is peripheral to this region. Together these fruit and nut plants are rich in carbohydrates, proteins and vitamins, but more importantly many are oily, flavorsome and some are sweet.

Grape seed remains, both wild and domesticated, have recently been discovered in the Levant at Nahal Oran in Kebaran and Natufian levels (ca. 11000 BP and 10000 BP) (Hillman 1975), which according to Zohary and Spiegel-Roy (1975), is well outside the normal range of the plant. Nahal Oran also provides the earliest evidence for fig exploitation in Kebaran levels and olive in Pre-pottery Neolithic B Levels (c. 9500 BP). Almonds and apple seeds occur in Neolithic strata at Hacilar and Catal Huyuk (8500-8000 BP) (Helbaek 1970).

Oils and related products have long been important in Southwest Asia in cooking and for use as incense, perfumes, resins, gums or simply for burning. Many were obtained from a variety of plant sources including olive, flax and legumes, while the range of species exploited throughout the region in Mesolithic and Neolithic times suggests that many were subject to protection and perhaps cultivation. The pistacho *(Pistacia atlantica)*, which is found on archaeological sites only in the form of seeds, is an abundant plant with a variety of uses including incense, resin and gum. The sap of the pistacho produces turpentine and its bark can be used in tanning. Of course, the nuts can be eaten raw or baked or ground into a flour.

Seasonings and flavorings were also common in Southwest Asia. Caper *(Capparis spinosa)* berries and seeds can be used fresh or can be pickled or ground. They are present at a number of early sites including Tell Abu Hureyra and Ali Kosh. Many other plants belonging to this category, which have been widely exploited in this region since historical records first began, are rarely found on archaeological sites. One reason for this may be that the parts exploited for their flavor are often seeds which are ground, such as coriander, cumin and caraway, or leaves such as dill, rosemary and other herbs. Many of the items were probably only used in small quantities and some which were valuable were undoubtedly carefully conserved and stored. In such cases it is unlikely that traces will survive in the archaeological record although there are a few fenugreek seeds from Neolithic levels at Hacilar (ca. 7450 BP). Hackberry *(Celtis australis)* and juniper have been found in the Neolithic Anatolian sites and both can be used in the preparation of alcoholic beverages. Juniper is also used as an aromatic resin in bread. The botanist Helbaek (1970:230), commenting on the presence of juniper seeds in a cache of wheat at Hacilar writes: " . . . it could be possible that the fragrance was appreciated for some culinary purpose by the Chalcolithic Hacilar." Other plants which may also have been highly valued in this area as aromatics, such as the Damask rose and myrrh, play an important role in cultural life at later periods in history, although their exact antiquity is unclear.

In considering the changes in subsistence patterns in Southwest Asia, the development of animal domestication may also be relevant to our hypothesis. Meat is often highly prized among many communities, especially hunter/gatherers, although even among these groups it often forms only a minor portion of the total diet of the people. Not just meat but particular cuts, fatty parts and specific organs are often esteemed and the hunter who procured such food often held a position of importance in the community. But there are major difficulties in not only supplying meat to communities through hunting but also in keeping it fresh. The status of meat as highly prized food is transitory. It should be pointed out that animals, like plants, supply a wide range of resources besides meat, blood and milk, animals also provide hair, hides, horn, sinew, bones, perfumes and flavorings.

It could be argued that in order to secure a regular and reliable supply of animal resources people intensified the relationship between man and naturally herding animals, such as sheep, goats and cattle (and in the Andes, llamas) to the point of "ownership" and began a process of selective culling and breeding which ultimately led to domestication. Thus the resources were stored on the hoof and the herd themselves became a resource which increased the wealth and status of the "owner" and could be converted into other sources of value and status through exchange for women, goods or even other foods. The early dates for the domestication of certain animals, such as the gazelle and goat in the Near East in Mesolithic and early Neolithic times (from ca. 11000 BP), and the llama in the central Andes (from ca. 7000 BP) therefore appear to be more acceptable. The domestication of plants and animals may both have been the result of attempts to maximize resources highly culturally valued in specific societies.

THE CULINARY ACHIEVEMENT

Many items, which were culturally valued, may have been in demand long before people took up cultivation. The increase in demand for such items, their intensification as well as the increase in the range of their uses, however, may have been influenced by other cultural developments. Of particular importance in terms of the use of foodstuffs may well have been developments in culinary traditions.

Until quite recently there has been little interest among anthropologists in culinary traditions of other cultures, but there are signs that this attitude is changing (Arnott 1975; Kuper 1977; Fenton & Owen 1981; Goody 1982). Levi-Strauss (1966; 1969; 1973; 1979; 1981) in particular has examined the importance of cooking in human affairs, a crucial aspect of cultural tradition in many cultures, particularly among South American Indians and this subject has been the focus of much of his research. Food, because it is consumed by people, shared by people, sustains human communities and dominates so much of their activity, is surrounded with a rich corpus of cultural meaning. Wild food sources are somehow transformed into edible, acceptable "cultural" items through the process of preparation, cooking and presentation before they are consumed. This is the culinary achievement and its meanings and importance in many cultures has been greatly elaborated since prehistory.

A number of foods can be eaten raw and many are preferred in this state. But many other foods cannot be consumed raw, not just because they are indigestible or unpalatable but also because they are poisonous or otherwise injurous to health if not processed in some manner. Undoubtedly the great store of knowledge regarding plant and animal species that people built up over the millennia that they subsisted as hunter/gatherers was not only concerned with where to locate sources of food, but also with their properties as plants and as potential food substances. The knowledge and skills which were developed involved how to transform these objects into useful resources and to extend their uses for new and varied ends. It is logical that this skill and knowledge eventually involved the manipulation of plants and animals and in terms of preparation, cooking and presentation these were concentrated in the environs of campsites.

Cooking is an advanced form of processing and the finished product a high point of cultural achievement.[4] In this processing and cooking a number of techniques are employed often utilizing developments in technology: cutting, grating, pulping, grinding, etc. Cooking is often achieved through a careful exploitation of heat and belongs in part to people's skilled use of fire in a number of contexts. Cooking also involves the combination of often quite different substances, sometimes associated with the use of fire. It is thus an elementary form of chemistry. This transformation through cooking, and other forms of processing, also assisted in the preservation of foodstuffs.

Cooking methods observable in ethnographic situations vary considerably. The most basic, and perhaps the oldest, involves the direct application of heat in roasting which required little skill and a simple technology. Meats can be roasted and certain nuts, fruits, roots and cereals can be treated in the same manner. But many plant sources are better cooked in containers through boiling, baking, braising, steaming, or frying. Such techniques are probably not as old as roasting though they too may have a considerable antiquity. Pottery or iron vessels are not a pre-requisite for such methods for gourds, bamboo (G. Benjamin, pers. comm.), leather (Ryder 1966), and earth ovens (Firth 1963:95-103; Sillitoe 1977) can also serve the purpose.

The role of cooking and processing in the development of demand for various foodstuffs is obvious. Cooking is a creative art, it encourages diversity and elaboration of existing techniques thus helping to establish new forms, tastes and desires. A number of resources, which assist in this process, include flavorings which not only play a crucial role in the process of cooking but also enhance the final outcome. The skillful use of rare, prized and exotic items extend the range of food possibilities and the need to maintain a regular supply of such items may well have been a major factor in establishing a demand for such sources to be near to the centers where processing and cooking took place—the hearth settlement.

The presentation of food should finally be considered. This involves notions of meals and appropriate dishes for a meal. Meals are often structured events, rich in symbolism and surrounded by rules, which are centers of social activity (Douglas 1975; 1982). The presentation of foods involves aesthetic considerations in terms of what the food looks like as much as how it tastes. These are important considerations in terms of the expansion and elaboration of food sources and thus a factor in what is exploited and cultivated as food in any particular culture.

THE CULINARY ARTS IN PREHISTORY

The evidence for the processing, cooking and presentation of food in prehistory is equally equivocal. Pottery is often considered more in terms of its form, decoration and fabric than its function. More attention has been paid to agricultural tools and cultivation methods than to the technology of food processing. Again, this is partly a result of the paucity of the archaeological evidence and a reflection of the nature of prehistoric research.

The use of fire appears very ancient. Hearths are claimed to have been present at Middle Pleistocene living sites, such as at Choukoutien in China. They are more common in later Pleistocene deposits where their presence is often equated with cooking, though what is being cooked and by what means is often unclear. Indeed, techniques of cooking are difficult to infer on many archaeological sites unless there are clear signs of ovens or fire-blackened containers which cannot be equated with other functions. Fire reddened stones in association with hearths are even more difficult to interpret, though charcoal from middens which may reveal the presence of oil when examined under a microscope, can perhaps be taken as an indication of cooking (Dickson 1977). Food remains around hearths in the form of carbonized and charred bones and plant remains may indicate roasting or baking, but, again, such interpretations should be treated with caution.

Stone and shell tools undoubtedly fulfilled many functions, making an interpretation of their use difficult, although the utilization of microscopic techniques to establish use wear pattern and plant gloss improve deduction in the area. Interpretation of such tools, however, often rests on the use of ethnographic analogy. Grindstones are often equated with the preparation of meal and flour even though such tools can also be used for grinding ochres and preparing other non-edible raw materials. In South America microliths are often set into boards for the processing of plants, particularly manioc. Where caches of microliths are found in archaeological contexts they have often been interpreted as evidence for the processing of such food. Recently DeBoer (1975) expressed doubts as to the validity of such claims, particularly concerning manioc preparation in prehistory.

Other aspects of food processing, such as soaking, leaching, freezing, squeezing, drying, peeling, threshing and winnowing, may be inferred from the use made of particular plants or parts of plants, but hard evidence is difficult to come by. The andean root complex, for example, requires soaking and freeze-drying to render edible certain tubers and to enable them to be stored. Archaeological evidence for such techniques is sparse because often no structures are needed for processing. Elsewhere in the world (in northwestern Europe and British Columbia) certain arrangements of postholes have been interpreted as drying racks for plants, meat and fish, even though such claims are little more than inferences from ethnographic analogies.

An interesting analysis of plant remains which may indicate processing has been put forward by Dennell (1974). Using a series of carbonized seed deposits from a number of Neolithic Bulgarian sites, Dennell has attempted to assess the stage of processing exhibited by the remains. On the basis of evidence of crop composition, seed size and other plant material placed within the archaeological context he claims to be able to distinguish four categories: post-threshing, post-winnowing, storage and cooking disasters!

Storage methods have been widely reported in the ethnographic literature for not only agriculturalists but also hunter/gatherers (see Testart 1982) and may be inferred for prehistory. The presence of prepared rooms, jars, caches, pits, racks, etc. have been recorded or inferred from various archaeological sites in many parts of the world.

Though most of the evidence for processing and cooking appears so negative an interesting case involves the processing and cooking of maize in the Americas recently reconsidered by Katz *et al.* (1974). Maize, by itself, is almost a complete diet. However, under normal cooking the amino acids lysine and tryptophan remain largely unavailable.[5] Therefore a diet based upon maize would lack one amino acid needed to make it a complete protein as well as niacin, one of the B group vitamins. Only if maize is boiled in an alkaline solution are lysine and tryptophan made available. Katz and his co-authors examined the distribution of maize cooking practices and established that cooking in alkali is present in Mesoamerica and North America but not in South America. This distribution of cooking methods may reflect different historical patterns to the diffusion of maize and cooking techniques. Maize originated in Mexico but spread to South America about 7-6000 years ago where it developed quite independently from Mexico with little subsequent contact (Pearsall 1978). Maize was spread to North America more recently, about 3-2000 years ago. Cooking in alkali, therefore, appears to have been invented some time between 6000 and 3000 BP in Mexico. Archaeological evidence for such a cooking technique is equivocal though it has been recently suggested that caches of land snails *(Pomacea* sp.) at Tikal may indicate that the shells were being used in cooking to supply alkali (Nations 1979). It is interesting to note that shell in abundant quantities is often found on archaeological sites in Mesoamerica. Finally the consumption of the *Phaseolus* spp. beans with maize appears to be much older than cooking techniques using alkali and it is known that such beans contain significant amounts of lysine and niacin.

EXOTICA, STAPLES AND THE DIFFUSION OF PLANTS

So far we have been discussing how culturally valued resources within a particular environment may have been the first items selected by man for special attention which eventually led to cultivation. The desire to secure a better supply of such items, however, or to seek out new forms need not have led directly to cultivation. Many items may have been impossible or extremely difficult to cultivate within the areas where certain people lived and so they may have been obtained from outside, where supplies were more regular, through a process of exchange with other communities. Such exchanges were to have an important effect on the history of cultivation.

If demand for a product within a particular environment is increased because it is needed for exchange purposes, then it follows that its value is increased, additional amounts will be needed to be produced and more regular supplies ensured. If the source is even rare within the environment within which it is found, or is seasonal or otherwise limited, then people will attempt to secure a more regular supply, perhaps through cultivation. Such items need not be rare but commonplace—they only become rare and thus valued once they travel some distances from their source. One person's exotic is another person's staple. Such a process may well have seen the production of staples within particular areas.

These exchanges encouraged not only the diffusion of processed plants but also the plants themselves, often accompanied with the knowledge and skills needed to establish the plants beyond their normal ranges. In this process an exotic might soon become merely an esteemed object, then commonplace and indeed become a staple.

This argument for the importance of exchange in the establishment, development and diffusion of plants and cultivation also works well for animal domestication. The exchange of meat or other poorly prepared animal products over large distances was difficult if the products began to deteriorate quickly. It was probably easier to move live animals, and once outside their normal ranges, such animals had to be carefully tended until required. Thus, in the exchange of animals not only did selection occur at the start of the exchange cycle, but the populations existing in other areas were carefully cared for. Such practices would have encouraged domestication to occur at a relatively fast rate.

THE EXCHANGE AND DIFFUSION OF FOOD RESOURCES IN PREHISTORY

While questions relating to trade and exchange are widely discussed in the archaeological literature they are nearly always concerned with the movement of material objects rather than of plants and animals. The movements of plants and animals are nearly always discussed in terms of diffusion (Sauer 1952), including the transfer of the knowledge and techniques of cultivation and often the migration of peoples. However, historical sources clearly indicate that there was extensive trade and exchange of foodstuffs in more recent times, sometimes quite localized but at others over considerable distances. These transfers may have been staples but many of the food items were small in quantity though high in value, particularly the trade in spices throughout the Old World (Miller 1969).

One problem in assessing the diffusion of crop plants and its importance in the early history of cultivation is in establishing their natural ranges. This can only be achieved by examining the contemporary distribution of their putative ancestors and most of the work in this field has been done on major Eurasian cereals. The diffusion of these has been the center of much discussion. Binford (1968) suggested that in the early post-Pleistocene in Southwest Asia wild stands of wheats and barleys were extensively exploited by people and produced sufficient surpluses to sustain population increases to a point where eventually pressure was placed on local resources. The greatest pressures were felt at the margins of the natural ranges of these cereals and it was in such locations that the techniques of cultivation were first developed in response to declining yields. Flannery (1969), reviewing the archaeological evidence for this hypothesis, showed that einkorn, emmer and two-rowed barley appear to have been brought into cultivation at the periphery of their natural ranges. The same applies to many of the items already discussed for Southwest Asia in this paper, fruit and nut trees and various herbs and spices.

An alternative, or perhaps a supplementary, hypothesis to this argument could be that plants (and animals) were moved outside their natural ranges in prehistory through the mechanism of trade and exchange (see the suggestive comments of Flannery 1965). Outside their natural ranges items would be exotics, in limited supply and highly valued. The desire to secure more reliable supplies and larger quantities of these plants (and animals) led to attempts to establish them outside their natural ranges. It could be argued against this hypothesis that trade and exchange can only occur at a later "stage" of cultural evolution, when large populations and complex social organizations have become established. Ethnographic evidence, and indeed much prehistoric evidence, proves such arguments have little foundation. In terms of Southwest Asia, recent research has established the importance of trade and exchange networks of items of material culture of high value over long distances (eg., obsidian *cf.* Renfrew, and Dixon 1976) and that such networks are extremely ancient. It may well be that plants, often associated with food resources, also traveled through similar networks.

Evidence from the other major centers of early cultivation suggest that similar patterns may have been involved in diffusion of plants and the techniques of cultivation while at the same time encouraging innovation. The diffusion of maize in the Americas has already been mentioned. The earliest evidence for maize in South America comes from Real Alto in Ecuador from levels dating to ca. 4445 BP, (Zevallos et al. 1977, Pearsall 1978), from Ayacucho in Peru in Chihua levels (6300-4700 BP) (MacNeish 1969, 1970) and from a number of locations on the north central coast in late Pre-Ceramic times (4500-3800 BP). The introduction of maize into Peruvian agriculture is but part of a larger trend in the diffusion of plants into this area. Plants from lowland South America, such as manioc, sweet potato, cotton and chili peppers as well as others from the eastern Andes, such as beans and peanuts, were introduced into an existing cultivation system based upon roots and tubers (Pickersgill 1969). The exploitation of these local and introduced staples as well as introduced legumes, condiments and drugs form the basis of very environmentally specialized agricultural systems (Brush 1976; Farrington 1980) which appear to have been integrated into a series of vertical economies (Murra 1972). Such systems can be identified throughout Andean prehistory from ca. 4500 BP (MacNeish, Browman & Patterson 1975).

Evidence for this massive diffusion of plants in South America is abundant but we lack information on the causes of plant movements. It may well be that trade and exchange played an important part in the movement, though studies of such systems have not been made on any scale. Lathrap (1973) has reconstructed the trade patterns for lowland South America for which he claims a considerable antiquity. Certainly many of the crops cultivated in Peru originated in the tropical lowlands. In the case of maize, it was difused very early, before it was even a staple in Mexico and Pearsall (1978:64) has suggested that in terms of South America " . . . this movements was probably not due to a large influx of people from the north, but rather a linear exchange of a new and interesting house garden plant."

Other examples from various areas of the world could also illustrate the point that the diffusion of plants as well as the knowledge and techniques of cultivation have been associated with patterns of trade and exchange. As a final point one might again indicate the tremendous exchanges of plants in Asia, particularly between India, China and mainland and island Southeast Asia. Proper study of this complex is still underway but it is interesting to note that the widespread distribution of many of the plants of Indonesia/New Guinea to distant parts of the world may well be associated with the expansion of maritime trading systems from the Indonesian archipelago (Urry 1981). Many of these crops are not staples but spices and were highly valuable trade items.

CONCLUSION

The early history of cultivation should be sought in cultural preferences for certain items highly valued by particular societies in the past. Among these highly valued items were foodstuffs, particularly food plants, and those which were likely first subject to cultivation were not staples but probably were more valued for their taste or other specific properties. The development and intensification of the cultivation of plants for food probably was enhanced by other cultural factors associated with increasing interest in food as a focus of cultural attention.

These factors included changes in preparation, processing, cooking and presentation. Highly valued food sources were also objects to be exchanged and their value increased as they were distributed outside their natural ranges. Such exchanges created new demands and cultivated plants helped establish more regular supplies. Hence knowledge about plants and cultivation, often accompanied by new techniques, were diffused over large areas.

Unlike many other models which see humans as basically uninnovative creatures at the mercy of the environment and forces beyond their control, we propose that humans are conscious actors in their worlds, creating and utilizing resources for cultural ends. The early history of cultivation must be seen as a major cultural achievement, establishing a richer use of resources and embellishing and extending all aspects of cultural life.

NOTES

[1]Helbaek (1966) reports that Pre-Pottery Neolithic barley remains from Beidha in Palestine show no signs of domestication but were found in large quantities and in association with domesticated emmer. He suggests that the barley should be regarded as a "cultivated wild" type.

[2]Within the category food we include drinks, particularly alcoholic beverages, which probably were also important in the developments discussed below.

[3]Brothwell and Brothwell (1969) provide a good overview of the sources of food and its dietary role in antiquity but say little about its cultural value.

[4]Good surveys of food processing in various areas of the world are rare, but see Yen (1975) for Oceania.

[5]In general maize is deficient in these essential amino acids. Tryptophan is the predursor of the vitamin niacin. Cooking in lime liberates both the amino acids and enables niacin to be produced thereby increasing the nutritional quality of maize though reducing its nutrient content.

LITERATURE CITED

ANDERSON, EDGAR. 1952. Plants, man and life. Little, Brown, Boston.

ARNOTT, MARGARET L. ed. 1975. Gastronomy: the anthropology of food and food habits. Mouton, Paris.

BINFORD, L.R. 1968. Post-Pleistocene adaptations. Pp. 313-341 *in* New Perspectives in Archeology by S.R. and L.R. Binford. Aldine, Chicago.

BROTHWELL, DON & P. BROTHWELL. 1969. Food in antiquity: a survey of the diet of early peoples. Thames & Hudson, London.

BRUSH, S.B. 1976. Man's use of an Andean ecosystem. Human Ecol. 4:147-166.

CHANG, K.C. 1977. Food in Chinese culture: anthropological and historical perspectives. Yale Univ. Press, New Haven.

DEBOER, W.R. 1975. The archeological evidence for manioc cultivation. Amer. Antiq. 40:305-314.

DENNELL, R.W. 1974. botanical evidence for prehistoric crop processing. J. Archeol. Sci. 1:275-284.

DICKSON, F.P. 1977. Identification of buried middens by soil analysis. The Artefact 2:133-139.

DOUGLAS, MARY. 1966. Purity and danger: an analysis of concepts of pollution and taboo. Routledge & Kegan Paul, London.

_________. 1975. Deciphering a meal. Pp. 249-275 *in* Implicit meanings: essays in anthropology. Routledge & Kegan Paul, London.

_________. 1982. Food as a system of communication. Pp. 82-124 *in* In the active voice. Routledge & Kegan Paul, London.

FARRINGTON, I.S. 1980. Contemporary agriculture and the vertical economy. Department of Prehistory and Anthropology, ANU, Canberra. (Cusichaca project, land use and irrigation research report, 2.)

FENTON, ALEXANDER & T.M. OWEN, eds. 1981. Food in perspective. John Donald, Edinburgh.

FIRTH, RAYMOND. 1963. We, the Tikopia: a sociological study of kinship in primitive Polynesia. Beacon Press, Boston.

FLANNERY, KENT V. 1965. The ecology of early food production in Mesopotamia. Science 147:1247-1256.

_________. 1969. Origins and ecological effects of early domestication in Iran and the Near East. Pp. 73-100 *in* The domestication and exploitation of plants and animals (P.J. Ucko and G.W. Dimbleby, eds). Duckworth, London.

GLOVER, I.C. 1977. Prehistoric plant remains from Southeast Asia with special reference to rice. Pp. *in* South Asian archeology. M. Taddei. Istituto Universitario Orientale, Naples.

GOODY, JACK. 1981. Cooking, cuisine and class: a study in comparative sociology. Cambridge Univ. Press, Cambridge.

GORMAN, C. 1970. Excavations at Spirit Cave, North Thailand: some interim interpretations. Asian Persp. 13:79-107.

HARLAN, J.R. 1975. Crops and man. Amer. Soc. of Agronomy, Madison, Wisconsin.

HARRIS, DAVID R. 1969. Agricultural systems, ecosystems and the origins of agriculture. Pp. 3-15 *in* The domestication and exploitation of plants and animals (P.J. Ucko and G.W. Dimbleby, eds.) Duckworth, London.

_________. 1973. The prehistory of tropical agriculture: an ethnoecological model. Pp. 391-417 *in* The explanation of culture change (C. Renfrew, ed.). Duckworth, London.

HAWKES, J.G. 1969. The ecological background of plant domestication. Pp. 17-29 *in* The domestication and exploitation of plants and animals (P.J. Ucko & G.W. Dimbleby, eds.). Duckworth, London.

HELBAEK, H. 1966. Pre-pottery Neolithic farming at Beidha. Palestine

LITERATURE CITED (continued)

Expl. Quart. 98:61-66.

__________. 1970. The plant husbandry of Hacilar. Pp. 189-244 *in* Excavations at Hacilar. J. Mellaart. Edinburgh Univ. Press, Edinburgh.

HILLMAN, G. 1975. The plant remains from Tell Abu Hureyra: a preliminary report. Pp. 50-77 *in* Excavations of Tell Abu Hureyra in Syria. A.M.T. Moore, G.C. Hillman & A.J. Legge. Proc. Prehist. soc. 41.

HO PING TI. 1977. The indigenous origins of Chinese agriculture. Pp. 413-484 *in* Origins of agriculture (C.A. Reed, ed.). Mouton, Paris.

HUBBARD, R.N.L.B. 1975. Assessing the botanical component of human palaeoeconomies. Bull. Inst. Archeol. 12:197-205.

HUTCHINSON, J. *et al.* 1977. The early history of agriculture. Oxford Univ. Press, Oxford.

JONES, R. 1975. The Neolithic/Palaelithic and the hunter gardeners: man and land in the Antipodes. Pp. 21-34 *in* Quaternary studies. R.P. Suggate & M.M. Cresswell. (Royal Soc. New Zealand Bull. 13.).

KATZ, S.H., M.L. HEDIGER & L.A. VALLEROY. 1974. Traditional maize processing techniques in the New World. Science 184:765-773.

KUPER, J. 1977. The anthropologists' cookbook. Routledge & Kegan Paul, London.

LATHRAP, D.W. 1973. The antiquity and importance of long distance trade relationships in the moist tropics of pre-Columbian South America. World Archaeol. 5:170-186.

LEGGE, A.J. & R.W. DENNELL. 1973. Plant remains. Pp. 75-99 *in* Recent excavations at Nahal Oran, Israel. T. Noy, A.J. Legge & E.S. Higgs. Proc. Prehist. Soc. 39.

LEVI-STRAUSS, C. 1966. The culinary triangle. New Soc. 22nd December: 937-940.

__________. 1969. The raw and the cooked. Jonathan Cape, London.

__________. 1973. From honey to ashes. Jonathan Cape, London.

__________. 1979. The origin of table manners. Jonathan Cape, London.

__________. 1981. The naked man. Jonathan Cape, London.

MACNEISH, R.S. 1967. A summary of subsistence. The prehistory of the Tehuacan Valley: Vol. 1 Environment and subsistence (D.S. Byers ed.). Texas Univ. Press, Austin.

__________. 1969. First annual report of the Ayacucho archeological-botanical project. Phillips Academy, Andover, Mass.

__________. 1970. Second annual report of the Ayacucho archeological-botanical project. Phillips Academy, Andover, Mass.

__________. 1975. T.C. Patterson & D.L. Brownman. The Central Peruvian interaction sphere. Phillips Academy, Andover, Mass. (Pap. Robert S. Peabody Founda. for Archeol. 7.).

MILLER, I. 1969. The spice trade of the Roman Empire. Oxford Univ. Press, Oxford.

MURRA, J.V. 1972. El "control vertical" de un maximo de pisos ecologicos en la economia de las sociedades Andinas. Inigo Ortiz de Zuniga, visitador, Visita de la Provincia de Leon de Huanuco en 1562. Universidad Nacional Hermilio Valdizan, Huanuco.

NATIONS, J.D. 1979. Shell snails and maize preparation: a Lacandon Maya analogy. Amer. Antiq. 44:568-571.

PEARSALL, D.M. 1978. Early movement of maize betwen Mesoamerica and South America. J. Steward Anthrop. Soc. 9:41-75.

PICKERSGILL, B. 1969. The archeological record of chili peppers *(Capsicum* spp.) and the sequence of plant domestication in Peru. Amer. Antiq. 34:54-61.

REED, C.A. ed. 1977. The origin of agriculture. Mouton, Paris.

LITERATURE CITED (continued)

RENFREW, C. & J. DIXON. 1976. Obsidian in western Asia: a review? Pp. 137-150 *in* Problems in economic and social archeology (G. de G. Sieveking, I.H. Longworth & K.E. Wilson, eds.). Duckworth, London.

RYDER, M.L. 1966. Can one cook in a skin? Antiq. 40:225-227.

SAUER, C.O. 1952. Agricultural origins and dispersals. Amer. Geog. Soc., New York.

SCHAFER, E.H. 1963. The golden peaches of Samarkand: a study of T'ang exotics. Univ. California Press, Berkeley.

STILLITOE, PAUL. 1977. The earth oven: an alternative to the barbecue from the Highlands of Papua New Guinea. Pp. 206-213 *in* The anthropologists' cookbook. J. Kuper. Routledge & Kegan Paul, London.

STRUEVER, S. ed. 1971. Prehistoric agriculture. Amer. Museum of Natural History, New York.

TAMBIAH, S.J. 1969. Animals are good to think and go to prohibit. Ethnol. 8:424-459.

TESTART, ALAIN. 1982. The significance of food storage among hunter-gatherers: residence patterns, population densities, and social inequalities. Curr. Anthrop. 25:523-537.

URRY, J. 1981. A view from the west: inland, lowland and islands in Indonesian prehistory. Unpubl. Ms. presented to the 51st ANZAAS Congress, Brisbane.

WILKE, P.J., R. BETTINGER, T.F. KING, & J.F. O'CONNELL. 1972. Harvest selection and domestication in seed plants. Antiq. 46:203-209.

YEN, D.E. 1975. Indigenous food processing in Oceania. Pp. 147-168 *in* Gastronomy: the anthropology of food and food habits (M.L. Arnott, ed.). Mouton, Paris.

__________. 1977. Hoabinhian horticulture? The evidence and the questions from northwest Thailand. Pp. 567-599 *in* Sunda and Sahul: prehistoric studies in southeast Asia, Melanesia and Australia (J. Allen, C. Golson & R. Jones, eds.). Academic Press, New York.

ZEVALLOS, M.C., W.C. GALINAT, D.W. LATHRAP, E.R. LENG, J.G. MARCOS, & K.M. KLUMPP. 1977. the San Pablo corn kernel and its friends. Science 196:385-389.

ZOHARY, D. & P. SPIEGEL-ROY. 1975. Beginning of fruit growing in the Old World. Science 187:319-327.

RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS: FALL 1984 - FALL 1985

JOSEPH E. LAFERRIÈRE
Department of Ecology and Evolutionary Biology
University of Arizona
Tucson, AZ 85721

This is the third in an annual series of bibliographies listing selected dissertations drawn from the pages of Dissertation Abstracts (D.A.) (see also Hays 1983, Laferrière 1984). All three listings were made by scanning the titles and abstracts published in D.A. and making a subjective decision as to which ones might be relevant to work in ethnobiology or related disciplines such as ecological anthropology. Dissertations categorized in D.A. under Anthropology, American Studies, Linguistics, Language, Sociology, Ecology, Biology, Botany, Zoology, and Agriculture were considered for inclusion in the list. An attempt was made to be as inclusive as possible, but some other dissertations may have been overlooked. The compiler would be grateful for comments and suggestions as to dissertations which might be worthy of inclusion in next year's edition.

Hays (1983) listed only dissertations categorized under "anthropology" in volume A (Humanities and Social Sciences) of D.A., while Laferrière (1984 and the present work) include dissertations from volumes B (Sciences & Engineering) and C (European dissertations). The dates covered in each publication are: Hays (1983): Volume A: July 1981-June 1983; Laferrière (1984): Volume A: July 1983-September 1984, Volume B: January 1981-September 1984, Volume C: Autumn 1980-Fall 1984; Laferrière (1985) (this paper): Volume A: October 1984-August 1985, Volume B: October 1984-September 1985, Volume C: Winter 1985-Fall 1985. 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 alphabetically below, along with the year of acceptance, title, institution, length, advisor or major professor, number of the page in D.A. in which the abstract may be found, University Microfilms order number, and the ISBN number, when this information was given.

Most of the dissertations accepted at institutions in the United States may be obtained from University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106, either on microfilm or published by microfilm xerography. Current prices may be obtained by calling 313-761-4700 or 800-521-3042 (in Canada, 800-268-6090).

Canadian and European dissertations are not now available through UMI, although this may change in the future. Relatively few European universities participate in the D.A. abstracting service; hence those European dissertations listed represent a small proportion of the total. Abstracts of all the dissertations listed below are, however, published in English in Dissertation Abstracts.

ARNDT, ALDEN ALBERT, JR. (1984). A microprocessor computer system for field capture of archeological data. University of Minnesota, 281 pp. D.A. 45(8):2569-A. Order no. DA8424664.

BEDIGAN, DOROTHEA. (1984) *Sesamum indicum* L.: crop origin, diversity, chemistry, and ethnobotany. University of Illinois at Urbana-Champaign, 148 pp. D.A. 45(11): 3410-B. Order no. DA 8502071.

BESSE, ROBERT WELLS III. (1983) Environment, subsistence patterns, and socioeconomic alternatives among the Nana Iñupiat of northwest Alaska. University of Illinois at Urbana-Champaign, 333 pp. Director: Demitri Shimkin. D.A. 45(7): 2160-A. Order no. DA8409862.

BROCHADO, JOSE JOAQUIM JUSTINIANO PROENZA. (1984) An ecological model of the spread of pottery and agriculture into eastern South America. University of Illinois at Urbana-Champaign, 527 pp. D.A. 45(11):3391-A. Order no. DA8502084.

CARDALE SCHRIMPFF, MARIANNE VERE. (1972) Techniques of hand-weaving and allied arts in Colombia (with particular reference to indigenous methods and, where possible, including dyeing, fibre preparation and related subjects). University of Oxford [U.K.], 1341 pp. D.A. 45(8):2569-A, Order no. DA8417581.

GELB, ROBIN JOAN. (1984) Folk, indigenous, and modern medicine in urban India: a study of the process of health care utilization. University of Wisconsin-Madison, 209 pp. Director: Joseph W. Elder. D.A. 45(5):1459-A. Order no. DA 8414236.

GROENFELDT, DAVID JOHN. (1984) Change, persistence, and the impact of irrigation: a controlled comparison of two North Indian villages. University of Arizona, 349 pp. Director: Earl W. Jernigan. D.A. 45(8):2572-A. Order no. DA 8424924.

GROFFMAN, PETER MARK. (1984) Ecology of nitrogen cycling in conventional cycling and no-tillage agroecosystems. University of Georgia, 182 pp. Director: D.A. Crossley, Jr. D.A. 45(6):1668-B. Order no. DA 8421115.

GYLLENHALL, CHARLOTE. (1984) Cultural and ecological factors affecting nutrient dynamics and crop yields in shifting cultivation. University of Alabama, 352 pp. D.A. 45(7):2026-B. Order no. DA8423481.

HAUN, ALAN EDWARD. (1984) Prehistoric subsistence, population, and sociopolitical evolution on Ponape, Micronesia. University of Oregon, 329 pp. Director: William S. Ayres. D.A. 45(7):2155-A. Order no. DA8422847.

HESS, SALINDA. (1984) Domestic medicine and indigenous medical systems in Haiti: culture and political economy of health in a disemic society. McGill University. D.A. 45(9):2912-A.

HOPKINS, DAVID CHARLES. (1984) Agricultural subsistence in the Early Iron Age Highlands of Canaan. Vanderbilt University, 550 pp. Director: Douglas A. Knight. D.A. 45(5):1454-A. Order no. DA8417017.

HORN, DARWIN DAVID, JR. (1984) Marsh resource utilization and the ethnoarcheology of the Uru-Muratos of highland Bolivia. Washington University, 411 pp. Director: David L. Browman. D.A. 45(5):1455-A. Order no. DA8418739.

JONES, KEVIN THOMAS. (1984) Hunting and gathering by early hominids; a study in archeological method and theory: University of Utah, 181 pp., Director: James F. O'Connell. D.A. 45(11):3392-A. Order no. DA8501529.

KÄLLMAN, S.J.T. (1983) Näringsvärden i vilda svenska växter - Analyser och Fysioogiska studier av olika komponenter med tonvikt på hohlhydrater, protein och vitamin C [Nutritive value of wild Swedish plants - Analyses and physiological studies of different components, with special reference to carbohydrates, protein, and ascorbic acid]. Stockholms Universitet [Sweden], 130 pp. [in Swedish]. D.A. 45(4):1002-C. ISBN 91-7146-259-7. [Published by University of Stockholm, Institute of Botany, S-106 91 Stockholm].

KERBER, JORDAN EDWARD. (1984) Prehistoric occupation and changing environment of Potowomut Neck, Warwick, Rhode Island: an interdisciplinary approach. Brown University, 284 pp. D.A. 45(7):2156-A. Order no. DA8422445.

LENSINK, STEPHEN CRAIG. (1984) A quantitative model of central-place foraging among prehistoric hunter-gatherers (vols. I and II). University of Iowa, 663 pp. Director: Duane C. Anderson. D.A. 45(9):2908-A. Order no. DA8428252.

LENTZ, DAVID LEWIS. (1984) A description of the plant communities and archaeo-ethnobotany of the Lower Sulaco and Humuya River Valleys, Honduras. University of Alabama, 213 pp. D.A. 45(7):2021-B. Order no. DA8423495.

LORD, KENNETH JONES. (1984) The zooarcheology of Hinds Cave (41 VV 456). University of Texas at Austin, 310 pp. Director: Dee Ann Story. D.A. 46(2):458-A. Order no. DA8508305.

LUCKING, LAURIE JO. (1984) An archeological investigation of prehistoric Palauan terraces. University of Minnesota, 272 pp. D.A. 45(12):3676-A. Order no. DA8503076.

MACRAE, WILLIAM DONALD. (1984) Ethnobiological and chemical investigations of selected Amazonian plants. University of British Columbia. Director: G.H.N. Towers. D.A. 45(12):3704-B.

MCCABE, J. TERRANCE. (1985) Livestock management among the Turkana: a social and ecological analysis of herding in an East African pastoral population. State University of New York at Binghampton, 332 pp. D.A. 46(2):460-A. Order no. DA8508655.

MCKENNA, DENNIS JON. (1984) Monoamine oxidase inhibitors in Amazonian hallucinogenic plants: ethnobotanical, phytochemical, and pharmacological investigations. University of British Columbia. Director: G.H.N. Towers. D.A. 45(12): 3704-B.

MELTZER, DAVID JEFFREY. (1984) Late Pleistocene human adaptations in eastern North America. University of Washington, 454 pp. Director: Robert C. Dunnell. D.A. 45(5):1456-A. Order no. DA8419172.

MERRILL SANDS, DEBORAH MARIE. (1984) The mixed subsistence-commercial production system in the peasant economy of Yucatan, Mexico: an anthropological study in commercial beekeeping. Cornell University, 587 pp. D.A. 45(9):2913-A. Order no. DA8427282.

PEREVOLOTSKY, ABRAHAM. (1984) Goat herding in Piura-Peru: the environmental context and the human factor. University of California at Davis, 259 pp. D.A. 45(4):1104-B. Order no. DA8416907.

RAMQUIST, P.H. (1983) On the origin, function, and development of sedentary Iron Age settlement in northern Spain. Umea Universitat [Sweden], 230 pp. D.A. 46(3): 600-C. ISBN 91-7174-145-4.

SAMSON, FILLES. (1983) Prehistoire du Mushau Nipi, Nouveau-Quebec: etude du mode d'adaptation a l'interieur des terres hemi-artiques [Prehistory of Mushau Nipi, New Quebec: study of the mode of adaptation in the interior of semi-Arctic lands]. University of Toronto, [in French]. D.A. 45(4):1154-A.

SCHNEIDER, KIM NAN. (1984) Subsistence, nutrition, and dental disease among prehistoric Ohio Amerindians. Ohio State University, 184 pp. Director: Paul W. Sciulli. D.A. 45(8):2575-A. Order no. DA8426473.

SCHULTZ, BRIAN BUETTNER. (1984) Ecological aspects of stability in polycultures versus sets of monocultures of annual crops. University of Michigan, 226 pp. Director: John Vandemeer. D.A. 45(7):2028-B. Order no. DA8422329.

SIMMS, STEVEN RODNEY. (1984) Aboriginal Great Basin foraging strategies: an evolutionary analysis. University of Utah, 298 pp. Director: James F. O'Connell. D.A. 45(9):2909-A. Order no. DA8426859.

SUN, PAO-KONG. (1984) Scapula system: a computerized retrieval system for archeological data from the Upper Wabash drainage. Ball State University, 157 pp. Director: Dwight W. Hoover. D.A. 45(5):1457-A. Order no. DA8417063.

WIDGREN, M.O. (1983) Settlement and farming systems in the early Iron Age: a study of fossil agrarian landscapes in Ostergotland, Sweden. Stockholms Universitet [Sweden], 132 pp. D.A. 45(4):942-C. ISBN 91-22-00602-8. [published by Almquist & Wiskell International, P.O. Box 45150, S-104 30 Stockholm.]

WIESE, ANN MARIE. (1984) Biology, ecology, and competitive effects of several annual weeds. University of Wisconsin-Madison, 94 pp. Director: Larry K. Binning. D.A. 45(9):2799-B. Order no. DA8422719.

ZAZUETA, AARON EDUARDO. (1984) The Mexican state and the modernization of agriculture in Caborca, Sonora, 1950-1982. University of California at Davis, 439 pp. D.A. 45(7):2166-A. Order no. DA8422507.

REFERENCES CITED

HAYS, TERENCE E. (1983) Recent anthropology doctoral dissertations of interest to ethnobiologists I. Journal of Ethnobiology 3(2):179-184.

LAFERRIERE, JOSEPH E. (1984) Recent doctoral dissertations of interest to ethnobiologists. Journal of Ethnobiology 4(2):201-206.

A LEGACY FOR THE FUTURE: Margaret Siwallace, 1908-1985

Margaret Siwallace was a grand individual—a sensitive and intelligent woman who intimately knew and readily discussed the issues facing Indian people today. A member of the Nuxalk Nation of Bella Coola, British Columbia, she was an important force for decades in the preservation of the culture of and for her people, and through the Nuxalk, of all Indian people. She worked with her people and with many scholars from distant universities to document and preserve the cultural traditions. Margaret was recognized for her leadership and work in many ways, and she was very proud and pleased to receive an honorary Doctor of Letters degree in May, 1985, from the University of British Columbia.

The ceremonial citation was written by Dr. K. Burridge who was guided by the numerous letters of support from noted academics, and it was read by President Smith at the convocation. In the citation, Margaret Siwallace was described as:

> " . . . a translator of excellence from the age of ten, moving familiarly and easily between English, Chinook and her native Bella Coola language. An intercultural woman of great personal and scholarly integrity, communicating the modes of one culture to those belonging to another.
>
> Margaret Siwallace has, through her life, been the principal source for many a paper and thesis in fields as diverse as ethnobotany, archaeology, history, anthropology, linguistics, nutrition, ethnomedicine, pharmacology and mythology. In this mixing with and informing a wide variety of scholars and scientists, of both local and international repute, she became and has for long been a true scholar and scientist in her own right, with a breadth of knowledge and insight given only to a few. She has been a fighter for Indian rights, working for her own community as well as for good relations with others. She has earned the respect, admiration and love of all who have encountered her, whatever their purposes or interests.
>
> With a rare sympathy and understanding combined with imagination and wide experience, Margaret Siwallace has mediated and unravelled many a knotty problem, be it in the field of politics, law, custom, science or more general scholarship. She is a great historian of her people. The parent of five, grandmother of eighteen and great grandmother of (more than) thirty, through a long life which has known dire tragedy as well as the extremes of material poverty, Margaret Siwallace has always been generous of herself, freely sharing with others the qualities and wealths of her mind and heart, her knowledge, her sympathy, her insight, enriching all who have come to her."

Margaret visited our home many times with her family and friends. Her last visit was to receive and celebrate her degree. During the week following her degree celebration Margaret was hospitalized for testing which revealed colon cancer. Surgery was recommended and scheduled for the end of July. She went home to Bella Coola for several weeks of celebrations with her family and friends, then returned to Vancouver, for the surgery. Margaret died in the hospital on August 8th following complications of surgery.

Her close friend and co-elder, Felicity Walkus, visited us in October with their common granddaughter, Louise Hilland and great-granddaughter, Chelsey. They were visiting with two other Nuxalk women, Sandy Moody and Rose Hands, to prepare and stage the Vancouver Arts, Sciences and Technology Centre exhibit and demonstration on Nuxalk foods. At dinner on their final evening with us the stereo system shorted out and made a loud, booming shout, which startled all of us.

Felicity said, "It's Margaret, coming to be with us."

We were to be very quiet while Felicity gathered several morsels of food from the table into a napkin and placed them bit-by-bit into the flames of the fireplace. While doing this she was speaking and singing in the Nuxalk language. We were all happy to know that Margaret was so mysteriously with us during the evening.

Sadly, Felicity, too, is now gone, having passed away on January 8, 1986. Margaret and Felicity were famous friends, contrasting colleagues and helpmates to one-another. The Nuxalk have lost two great educators, but because of their efforts with the Nuxalk community of elders, the legacy of preserving the Nuxalk cultural traditions will prevail with their people and their future generations.

Harriet Kuhnlein

Editor's note: Please refer to Sketches in the Sand, *Journal of Ethnobiology* 5:(1)i for an acknowledgment by the *Journal* and the Society of Margaret Siwallace's honorary degree.

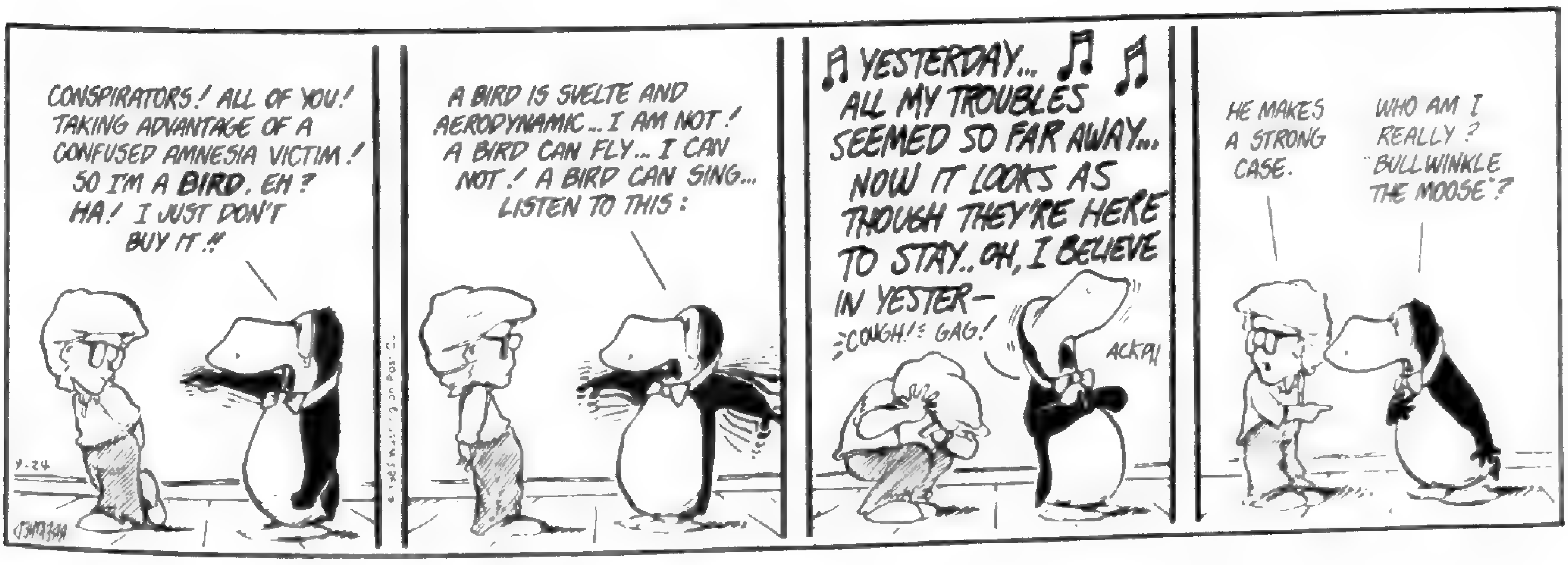
NEWS AND COMMENTS

NINTH ANNUAL ETHNOBIOLOGY CONFERENCE ALBUQUERQUE, NEW MEXICO

The Ninth Annual Ethnobiology Conference will be held 21-23 March 1986 at the Univesity of New Mexico in Albuquerque. Sponsors are the Department of Biology at the University and the New Mexico State Department of Natural Resources. A Pueblo Feast is promised with Native American dancers to entertain and Dr. Vorsila Bohrer to present the keynote address. To register send $20 (check made payable to the Department of Biology, or $25 after 10 March) to:

Ninth Ethnobiology Conference
Castetter Lab, Department of Biology
University of New Mexico
Albuquerque, New Mexico 87131

ETHNOBIOLOGY IN BLOOM COUNTY



This Bloom County cartoon was submitted by William Sturtevant. The central issues of folk biological classification theory continue to receive thoughtful commentary in the comics. May we take this as a sign of the universality of the questions addressed by this field?

NUTRICOMP: AN ETHNOBOTANICAL COMPUTER PROGRAM

Joseph E. Laferriere, in cooperation with Gary Nabhan and Native Seeds/SEARCH, has developed a computer program called "Nutricomp," to store and analyze information about the nutritional composition of native plants. This system allows unusual flexibility in entering data, as it handles much of the coding for efficient use of disk space. Numerical values may be entered in whatever form they appear in the original publication; the computer will translate these values into a standardized format.

The program may also be used to analyze the information. For example, the user, by specifying taxa, plant parts, preparation techniques, nutrients, and tribes/geographical regions, can obtain averages for all samples in the file that match desired criteria.

The program is currently being used to store information on the native plants of the Southwest (the compiled data will be published soon), but the program can be adapted for use in other regions. It is written in extended BASIC for use on a Sanyo MBC-550 128K micro-computer, but may be adapted to any IBM-compatible system. for more information contact LaFerriere, Department of Ecology and Evlutionary Biology, University of Arizona, Tucson, AZ 85721 / (602) 623-6701.

SCHOOL FOR FIELD STUDIES SEEKS STAFF FOR ECUADOR FIELD SCHOOL

The School for Field Studies (196 Broadway, Cambridge, MA 02139 / Telephone: (617) 497-9000) offers a broad range of environmental field courses for undergraduates. courses are designed to provide undergraduate students a challenging educational experience stressing environmental issues. The courses are academically rigorous. The students are immersed in field research as well as course material. SFS is an independent organization, however students may receive credit through Northeastern University.

A Medicinal Botany course will be offered twice during the summer of 1986 in Ecuador. Two faculty members will work with fifteen students in each session (approximate dates: June 16-July 15, July 22-August 20). The school seeks faculty with advanced degrees in biology/botany or anthropology and with ethnobotany field research experience. They should be committed to teaching. Faculty design their own program, prepare a syllabus, and arrange course logistics in conjunction with SFS. Faculty honoraria will be $1000 to $1600/month, depending on qualifications, with travel and field expenses paid.

To apply send vitae, references, and a letter citing your special qualifications to the above address.

MELVILLE AND ELIZABETH JACOBS RESEARCH FUND
Whatcom Museum Society

The Melville and Elizabeth Jacobs Research Fund invites applications for small individual grants to support research on Native American cultures, primarily of northwestern North America. The Fund is designed to facilitate field research rather than analysis of previously collected materials. Appropriate are field studies of any aspect of culture and society, with emphasis on expressive, conceptual, and purely linguistic systems. (Projects in archeology, physical anthropology, urban anthropology, and applied anthropology or applied linguistics will not be funded.) Awards range from $200 to approximately $800; salary cannot be supplied, and only minimum living expenses can be considered.

For further information and application forms, contact the Melville and Elizabeth Jacobs Research Fund, Whatcom Museum of History and Art, 121 Prospect Street, Bellingham, Washington 98225. ***Application deadline is February 15, 1986.***

Journal of Ethnobiology INDEX TO KEY WORDS Volume 1, Number 1 through Volume 5, Number 2

Editor's Note. In this compilation of key words, the number in bold face type immediately following an entry indicates the volume (1 through 5); the year the volume was published can be calculated by adding 1980 to the volume number, thus volume 5 was published in 1985. The pages within a volume run continuously, eliminating the need to give the number within a volume. Since this is an abridged index and since key words are often implicit as concepts on pages in addition to those on which they actually appear, I decided to give pages numbers of the entire paper rather than specific pages of index entries as is usual with more comprehensive treatments. For the most part, authors selected the key words for inclusion in this index. In those few instances where authors did not respond, selections were made by the editorial staff. I am grateful to Maria Romero, editorial assistant, for assistance with this compilation.

Reprints of this index are available at a cost of U.S. $2.00 from the Secretary/Treasurer (for the address see the inside front cover of this issue or the most recent issue in the future). Make checks payable to *Journal of Ethnobiology*.

A

D

O

P

Q

R

Volume 1, Number 1 May 1981

CONTENTS

NOTICE TO AUTHORS

The *Journal of Ethnobiology* accepts papers on original research in ethnotaxonomy and folk classification, ethnobotany, ethnozoology, cultural ecology, plant domestication, zooarchaeology, archaeobotany, palynology, dendrochronology and ethnomedicine. Authors should follow the format for article organization and bibliographies from articles in this issue. All papers should be typed double-spaced with pica or elite type on 8½ x 11 inch paper with at least one inch margins on all sides. The ratio of tables and figures to text pages should not exceed 1:2-3. Tables should not duplicate material in either the text or graphs. All illustrations are considered figures and should be submitted reduced to a size which can be published within a journal page without further reduction. Photographs should be glossy prints of good contrast and sharpness with metric scales included when appropriate. All illustrations should have the author(s) name(s) written on the back with the figure number and a designation for the top of the figure. Legends for figures should be typed on a separate page at the end of the manuscript. Do not place footnotes at the bottom of the text pages; list these in order on a separate sheet at the end of the manuscript. Metric units should be used in all measurements. Type author(s) name(s) at the top left corner of each manuscript page; designate by handwritten notes in the left margin of manuscript pages where tables and graphs should appear.

If native language terminology is used as data, a consistent phonemic orthography should be employed, unless a practical alphabet or a more narrow phonetic transcription is justified. A brief characterization of this orthography and of the phonemix inventory of the language(s) described should be given in an initial note. To increase readability native terms should be indicated as ***bold-face italics*** to contrast with the normal use of *italic* type for foreign terms, such as latin binomials. If necessary, the distinction between lexical *glosses*, i.e., English language approximations of a term's referential meaning, and precise English equivalents or definitions should be indicated by enclosing the gloss in single quotation marks.

Authors must submit two copies of their manuscript plus the original copy and original figures. Papers not submitted in the correct format will be returned to the author. Submit your manuscripts to:

DR. WILLARD VAN ASDALL, Editor
Journal of Ethnobiology
Arizona State Museum, Building 26
University of Arizona
Tucson, Arizona 85721

NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Eugene Hunn, Department of Anthropology, DH-05, University of Washington, Seattle, Washington 98195.

BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from the readership of the *Journal*. Please send suggestions, comments, or reviews to Charles H. Miksicek, Office of Arid Lands Studies, University of Arizona, Tucson, Arizona 85721.

SUBSCRIPTIONS

Subscriptions to the *Journal of Ethnobiology* should be addressed to Steven D. Emslie, Department of Zoology, University of Florida, Gainesville, Florida 32611. Subscription rates are $35.00, institutional; $17.00 regular members, for U.S., Canada, and Mexico; foreign subscribers add $8.00. Write checks payable to *Journal of Ethnobiology*. Defective copies or copies lost in shipment will be replaced if written request is received within one year of issue.

CONTENTS