TOPICS AND ISSUES IN ETHNOENTOMOLOGY WITH SOME SUGGESTIONS FOR THE DEVELOPMENT OF HYPOTHESIS-GENERATION AND TESTING IN ETHNOBIOLOGY

DARRELL ADDISON POSEY
Laboratório de Etnobiologia
Departamento de Biologia
Universidade Federal do Maranhão
65,000 São Luiz, Maranhão (Brazil)

ABSTRACT.—This paper defines ethnoentomology, briefly traces the history of the field, surveys the literature in major subject areas and offers suggestions for continued research. Hypothesis-generation/testing is suggested as an important "intellectual bridge" to a world science that builds upon knowledge systems of all human societies. Examples are presented.

INTRODUCTION

Definitions, even for ethnoentomology, are often difficult to formulate, and, once formulated, are usually unsatisfactory. Insight and understanding is sometimes increased through a comparison with a related term or concept, hence the juxtaposition of "cultural entomology" and "ethnoentomology" in the discussion that follows.

Cultural entomology treats the influence of insects upon the "essence of humanity as expressed in the arts and humanities" (Hogue 1980). Cultural anthropologists usually restrict their studies to "advanced," industrialized, and literate societies, maintaining that entomological concerns of "primitive" or "noncivilized" societies are in the domain of ethnoentomology. They are principally interested in written forms of cultural expression and limit their studies to physically recorded sources of literate societies. It is well to note that this, like many divisions, is an artificial one, and it implies an ethnocentric "we/they" bias built upon assumptions of fundamental differences between "primitive" and "civilized" classification and thought. Thus far, anthropological research has not substantiated such assumptions.

Although the prefix "ethno" generally indicates knowledge of "folk" societies and the word cell "ento" refers to insects (thus ethnoentomology is concerned with the knowledge and use of insects in different human societies), defining the term is not as easy as might be expected. A fundamental problem is that of delimiting entomology itself. Even though the concept "insect" is clearly defined by Western science, entomologists also frequently study "related arthropods." Since these two concepts gradually developed in Western science, it cannot be assumed that they are universal and, in folk societies, must be elicited using *emic* procedures that "discover" conceptual paradigms rather than methods that impose preconceived concepts upon the society under study.

There are a number of areas within ethnoentomology which can be successfully researched through analyses based upon observations and data collection using the categories of Western science, ie., using the *etic* approach, without diminishing their ethnoscientific contribution. Examples include studies of insects as food, the role of arthropods in disease transmission, hallucinogenic insects, the use of insects for ornamentation, problems in contamination of food with insects, etc. Few studies have passed from the *etic* to the cognitive *emic* level. Yet the native (folk) view of insects—their naming, classification, and use—is surely the ultimate goal of ethnoentomology.

This paper gives a general survey of both *emic* and *etic* topics in ethnoentomology, utilizing the general Western concept "insects and related arthropods" as a unifying category for comparative study. Cultural entomology is treated as a subdivision of ethnoentomology that deals with recorded sources in literate societies. Cultural entomological interests will, therefore, be incorporated throughout the paper, although no attempt is made to review the vast literature.

The purpose of this review is to outline areas of interest for future ethnoentomological investigation, with an attempt made to establish ethnoentomology, and ethnobiology in general, as a hypothesis-generating and testing mechanism. That is, to show how folk knowledge and beliefs can serve to generate new ideas and hypotheses which can then be investigated and tested by our own science. This approach provides an intellectual bridge between Western and folk sciences as well as the basis for a non-culturally biased world science. The paper argues that folk specialists must be treated as scientists, with their respective systems regarded as invaluable codifications of human observations of natural phenomena.

A BRIEF HISTORY OF ETHNOENTOMOLOGY

Development of entomology as a folk science has been traced for Egypt (Efflaton 1929), the Middle East (Harpaz 1973), Greece and Rome (Scarborough 1979), and other parts of the world (Essig 1931; Montgomery 1959; Wilson and Boner 1937). Modern entomology acquired a distinctively humanistic flavor (and perhaps its "ethno" tendencies) from entomologist-philosophers such as William Morton Wheeler, Maurice Maeterlinck, and Jean Henri Fabre, who "not only described insect phenomena with imagination and brilliance, but wrote and spoke of their meaning on a human intellectual plane" (Hogue 1980). Contemporary ethnoentomology began in the Nineteenth Century with the works of Wallace (1852), Daoust (1858), Bates (1862), Hagen (1863), Katter (1883), Librecht (1886), Glock (1891), Marshall (1894), and Wagner (1895). Writings by Armbruster (1926), Arndt (1923), Barrett (1925), Caudell (1916), Dammerman (1929), Ealand (1929), Gudger (1925), Knortz (1910), Laufer (1927), and Nordenskiold (1929) brought the subject into the Twentieth Century. Essig's (1934) survey of the importance of insects to the Indians of California established the traditional categories of ethnoentomological interest.

Zinsser's (1935) *Rats, Lice and History* remains a classic because of its perspective of insects as forces in human social and biological history. *Insects as Human Food* (Bodenheimer 1951) likewise brought insects to world attention in a more positive light as a potential and important source of protein. Wyman and Bailey (1952) were the first to use the term ethnoentomology in print in their seminal work on the Navajo Indians.

The writings of Schimitschek (e.g. 1968, 1977) certainly establish him as a major force in cultural and ethnoentomology. Other general works include those by Clausen (1954), Cloudsly-Thompson (1976), Hitchcock (1962), Hogue (1980), Kevan (1974, 1979, 1980), Posey (1976, 1977, 1978, 1979, 1980, 1986), and Ritchie (1979).

Conklin's (1973) general bibliography of folk classification offers an important section of entries on ethnozoology (including ethnoentomology) and provides a bibliographic framework to link ethnoentomology with its theoretical roots in ethnoscience.

INSECTS AND HUMAN HISTORY

Zinsser's (1935) work popularized the knowledge of the association of insects with the spread of epidemic diseases that demolished empires and changed the course of human history. Subsequent works (Cloudsly-Thompson 1976; Hare 1954; McNeill 1976; Ritchie 1979; Sigerest 1951; Smith 1973) trace the plagues and pestilence caused by insect-borne diseases such as bubonic plague, typhus, yellow fever, and trypanosomiasis. Bushvine (1976) details the effects of ectoparasites on human hygiene and medical history.

Crosby (1972) analyzes the complexities of trans-Atlantic exchanges of insect-transmitted diseases and emphasizes the destructive impact of such on aboriginal populations of the New World. Often such devastation extended well into regions with no direct contact with Europeans. This was due to extensive aboriginal trade routes that brought goods infested with insect vectors deep into the hinterlands (Posey 1976). The complete impact of insect-related diseases is still little known for the Americas (Dobyns 1966).

Certainly the role of insects in human evolutionary history is indisputable. Students interested in this broad area should begin their studies by consulting the bibliographies of the above works.

INSECTS AND HUMAN FOOD

The most extensive literature in any subject of ethnoentomology concerns the relationship between insects and human food. The study of Entomophagy, the direct use of insects as human food, has a long and varied history. *Why Not Eat Insects?* (Holt 1885) stimulated a series of studies concerning the nutritional potential and importance of insects to the human diet. Subsequent general surveys (eg., Bergier 1941; Bodenheimer 1951; Conconi et al 1981; Curran 1939; Dufour 1981; Gorham 1976a,b; Harlan 1976; Hoffman 1947; Meyer-Rochow 1973, 1975, 1976, 1985; Ruddel 1973; Taylor 1975) have investigated the variations in cultural practice of entomophagy. Other studies have documented the biological efficiency of insect reproduction and the consequent production of protein (DeFoliart 1975; Dufour 1981; Meyer-Rochow 1975, 1976). Recent works discuss the practical problems of insect foods for Western societies, including socioeconomic factors, manpower, preparation, handling, and marketing (Conconi 1982; Dufour 1981; Gorman 1979; Ramirez et al 1973; Kok 1983).

Insects are also consumed indirectly through the ingestion of contaminated foods. This is because of the impossibility of complete removal of insect parts from food products (Caron 1978). Contamination necessitates the establishment of a complex set of rules and standards utilized by government food- and drug-regulating agencies (Taylor 1975). Detailed works outline the hazards of insect ingestion which include allergic reactions, poisoning, tumorigenic stimulation and related health problems (Chooviva-thanavanich et al 1970; Dufour 1981; Gorham 1975; Pimental et al 1977; Taylor 1975).

The major factors affecting insect consumption are not health hazards, however, but cultural biases. Bodenheimer's (1951) book on insects as human food stimulated a series of works regarding cultural traditions and taboos of insect eating (eg., Aeschlimann 1982; Catley 1963; Meyer-Rochow 1973, 1978; Ruddel 1973; Taylor 1975; Tihon 1946). Although Western societies have a particularly strong bias against insects as food, with honeybees being the only Arthropod systematically exploited for human food (Dufour 1981), many other societies have a long and extensive inventory of useful and edible species (eg., Aldrich 1921; Catley 1963; Daoust 1858; Tindale 1953; Wallace 1852; Silow 1976, 1983). Techniques for the evaluation of insect nutritional qualities have been developed (Coconi 1977; Coconi et al 1981, 1984; DeFoliart 1975; Tetotia and Miller 1974) and allow for the generation of numerous lists of species and their dietary potentials (eg., Dufour 1981; Redford and Dorea 1984; Taylor 1975). Such techniques are not without problems and refinements in protein and nutrient evaluation are still needed (Redford 1986).

Other indirect effects of insects include the enormous cost of agricultural chemicals used to control them. A dramatic worldwide increase in mechanized monocultural planting has led to sharp rises in epidemic outbreaks of insect pests and the resultant rise in crop loss (Altieri 1983; Cooper and Tinsley 1978). This trend, combined with soaring energy costs, has created serious global problems and threatened the stability of food prices in both developed and under-developed countries (Altieri 1985). Other farming trends, such as "no-till" planting, have led to increased vulnerability to some crop pests and greater dependency on herbicides; these herbicides, in turn, often increase the susceptibility of some crops to other insect and microbial pests (Oka and Pimentel 1974). This situation stimulates even greater dependency upon insecticides. All of these have contributed to re-establish the viability of traditional agriculture and the necessity of studying folk agriculture in detail.

Apart from the high costs of chemical agents, health hazards are alarming and ominous. Fatal and non-fatal poisoning from pesticides is common, and the long-term effects of ingestion through contaminated food and water are of wide concern (Gorman 1975, 1979; Pimental et al 1977; Taylor 1975).

Another problem is that for cosmetic and psychological reasons many types of insects are considered repulsive (Hosen 1980). That certain species are relished as edible delicacies in one society and viewed with dread or horror in another is a question of cultural "tastes." Yet as Dufour (1981) points out, attitudes toward insects can change. As world food supplies dwindle and long-term space travel becomes a way of life, consumption of insects may have to become acceptable (Pimental 1976). Insects are potentially one of the ideal sources of food and components in waste recycling in outer space because of their light weight, high quality of animal protein, and rapid reproductive rates (Miller 1981). Even so, any major changes in world diet will require a "desensitizing" to produce more positive attitudes towards insects in general and innovative marketing to introduce insect-based products (Dufour 1981).

INSECTS AND MEDICINE

It is in China that we find the most ancient and complete record of the use of insects in medicinal preparations. Read (1935) gives a detailed inventory of useful medicinal species. Chinese veterinary medicine had evolved to a point that curative diets and remedies were used to treat ailing crickets and silkworms (Laufer 1924; Read 1935).

Scarborough (1974b, 1981) gives evidence of the importance of certain insects in ancient Greek and Roman medicine. Numerous other surveys record diverse examples of insects in various cultures (Kevan 1979; Greenlee 1944; Meyer-Rochow 1985; Posey 1978; Swanton 1928). For example, in Brazil termites are used to treat bronchitis, catarrh and influenza, constipation, dog bite, goiter, incontinence, measles, protruding umbilicus, rheumatism, whooping cough, sores, boils, ulcers, etc. The treatments range from teas made from crushed insects or their nests to inhalation of smoke from burning termite cartons (Mill 1982). Principal insect groups listed in Brazil by Lenko and Papavaro (1979) for the variety of their medicinal uses are cockroaches (to treat alcoholism, asthma and bronchitis, colitis, constipation, tooth ache, etc.) and wasps (for stomach ache, wounds, spider bites, constipation, burns, etc.).

Bees are important in Kayapó Indian medicine. Different honeys are though to have different medicinal properties and are used for a variety of diseases. Pollen (collected by bees), larvae and pupae likewise have medicinal qualities. Smokes from different waxes are the most important and powerful curative substances: patients are either "bathed" in the smoke or inhale it. Houses are also "cleansed" by smokes from burnt beeswax, batumen, and resin (Posey 1983b, e, f; Posey and Camargo 1985).

Mixtures of wasps are though to be aphrodisiacs. Parts of the horns of the rhinoceros beetle (*Megasoma acaeon*, Dynastidae) are thought to give great sexual strength (Lenko and Papavaro 1979). Ant and wasp infusions are widely used to cure goiter, paralyses, and rheumatism (Ealand 1915). Perhaps most amazing is the use of stinging ants and wasps as cures for crippling arthritis (cf. News and Comments, *Journal of Ethnobiology* 3(1):97, 1983). Stings from these Hymenoptera are apparently effective in curing arthritis. Cures for certain types of blindness are also attributed to wasp stings (Araújo 1961). The Uapixana and Tiriô Indians also use ant stings to cure various maladies (Lenko and Papavaro 1979). In Brazil the enormous mandibles of *Atta* are used to suture wounds. The ants are allowed to bite the sides of the wound; when they close their jaws, their heads are broken off and the closed mandibles hold the would together (Gudger 1925).

Other diverse uses include Tindale's (1953) observation of grubs being used in Australia by the aboringines as a "substitute teat" to wean their children. The aborigines also commonly treat stomach ache and colds with a liquid prepared from crushed green-tree ants and larvae (McKeown 1944); crushed cockroaches are used to treat cuts (Rudell 1973). Clousdly-Thompson (1976) provides a long list of medicinal uses of insects in the ancient and modern world.

BEEKEEPING AND INSECT REARING

From ancient cave paintings of honey raids to beekeeping in Babylon, and the use of beeswax to embalm the dead in Assyria, Ransome (1937) traces the importance of "the Sacred Bee" in ancient times. Crane (1984) describes the "archaeology" of beekeeping recorded in historical texts and art. Crane (1979) also provides a comprehensive survey of production, collection and use of beeswax in many parts of the world. The literature is so extensive on the keeping of *Apis* in ancient and contemporary times that it cannot be reviewed herein.

Keeping of stingless bees (Meliponinae) is a much less known area of ethnoentomology. Yet the keeping of meliponine species was a highly developed science amongst native peoples of Africa and the Americas (Parent et al 1978; Schwarz 1945, 1948).

Schwarz (1948) provides one of the most complete studies on the domestication of meliponines by the Maya of Central America. These Indians were expert in the genetic manipulation of different bees to increase honey and wax productivity and perfected many methods for the division of colonies and the rearing of numerous species. Highly ornamented man-made hives were employed in special shelters constructed for the sacred bees and bee gods. The Maya had several methods to attract and "tame" wild swarms, which included attraction with plantations of flowering plants preferred by the bees. Such practices continued into modern times and are still observed in Mexico, Panama, and other parts of Central America (Bennett 1964, 1965; Hendricks 1941; Weaver and Luhrmann 1981; Weaver 1981).

Stingless beekeeping was also highly developed in pre-Colombian South America. Nordenskiöld (1929) provides an interesting survey of South American folk apiculture observed during the first half of this century.

For stingless bees in Brazil, Lenko and Papavaro (1979) record 171 folk names, the majority of which were of indigenous origin. Many scientific names are actually taken directly from their Tupi Indian language origin (Nogeira-Neto 1970).

Although some species of Meliponinae were undoubtedly fully domesticated in South America, many species were only semi-domesticated. Chagnon (1968) and Metraux (1948b) describe bee management by the Yanomamo and Guarani Indians, but they fall short of describing the bees as fully domesticated.

Contemporary Kayapô Indians of Brazil name and classify at least 56 folk species of stingless bee (Posey 1983e, f); nine species are semi-domesticated. Hives of these species are raided, and a portion of the brood comb (with some honey and pollen) is returned to the next before resealing, so that the bees re-establish the colony and the Indians continue to exploit the hive in subsequent years. In addition to the nine semi-domesticated species, the Kayapó mark the nests of several others and carefully observe the progress of the colonies. When the Indians think that the quantity of honey and/or wax sufficient, the nest is raided. Nests of some species, when found in the forest, are actually brought to the village to be observed on a daily basis (Posey and Camargo 1985). Other social insects reported to be "managed" include the sauva (*Atta* spp.) (Lenko and Papavero 1979), various wasp species (Baldus 1937; Chagnon 1973; Metraux 1984a), and honey-producing wasps (*Brachygaster*) (Lenko and Papavaro 1979).

Beetle grubs (Phalaenidae and Buprestidae) are raised by several South American tribes (Chagnon 1968; Stewart and Metraux 1948). Palm trees are deliberately cut to provide a fodder for egg-laying adults. The Indians know exactly when to return to the decaying pith to extract the numerous, large grubs. Coimbra (1984) offers detailed information on the rearing of four species of *Bruchidae* and *Curculionidae* larvae by the Suri Indians of Rondonia (Brazil).

.A sizeable bibliography exists regarding insect-rearing for laboratory experiments as well as livestock food (Calvart et al 1969; Chambers 1977; MacHargue 1917; Vanderzant 1974). One interesting study deals with the commercial management of *Hermetia illucens* larvae, which are used as fish bait in Brazil (Santos and Coimbra 1984).

Insects have been reared for a number of purposes. Laufer (1927) describes in detail how elaborate carved gourds and miniature houses were prepared for singing and fighting crickets with China (Fig. 1). Special shelters were prepared for them, during the summer, with clay beds built for each individual. Elaborate diets were recognized for different species in different lunar cycles. Special diets and medicines were available for ailing crickets. Intricate porcelain dishes were created for feeding the prized individuals. Even delicately carved "ticklers" were created to urge reluctant cricket warriors to battle. Kevan (1979) notes that American Indians likewise raised crickets "simply to enjoy their songs." Similar reports are found in Bates (1862), Caudel (1916), and Floericke (1922). Posey and Camargo (1985) report on the keeping of stingless bees purely because of the Kayapó Indians' fascination with social insects. Of course, cultivation of silk worms (*Bombyx*

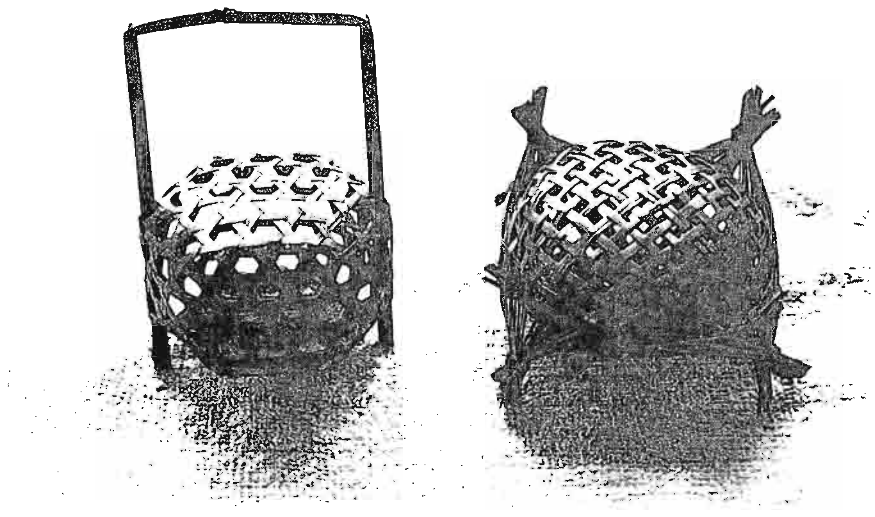

FIG. 1.—Special baskets used for keeping singing crickets in Asia. Courtesy of Dr. Nelson Papavero, Museu de Zoologia, São Paulo, Brazil.

mori) is another ancient Chinese tradition in insect rearing. The details of this folk science are described by Read (1935) and Cloudsly-Thompson (1976).

Scale insects *(Coccus cacti)* that feed on prickly pear *(Opuntia* spp.) are still raised in Mexico, Honduras, the Canary Islands, Algeria, Spain, and Peru because of their use in the production of the carmine-red pigment cochineal (Cloudsly-Thompson 1976; Ealand 1915). Similarly, "lac insects" *(Laccifer lacca)* are reared in Thailand, Burma, and India for their production of shellac, polishes, and sealing wax (Cloudsly-Thompson 1976).

PESTS AND PEST CONTROL

Was it a tarnished plant bug that caused the potato rot which led to the great Irish potato famine? Quite possibly, according to Wheeler (1981). If so, it probably was not the first ecological and social disaster wrought by insect pests. Although the roles of insects in agricultural history remains little known, we do know that today worldwide deforestation and the dominance of crop monocultures have provoked a sharp rise in insect pests (Cooper and Tinsley 1978; Thresh 1982). Likewise there have been dramatic increases in insect-borne diseases caused by blood parasites and arboviruses. These situations, along with the high costs of pesticides and energy for their applications, have stimulated a refreshing new emphasis upon studies of pest management in traditional agriculture (Altieri 1985).

Western agriculturalists have generally assumed traditional agricultural systems to be of low productivity and have used "bigger yield" as their justification for expensive technologies and chemical dependency (Alverson 1984). Yet in many cases, native agriculture has been shown to be both productive and efficient in its use of local skills, available energy, and materials (Egger 1981; Kerr and Posey 1984; Parker et al 1983; Posey 1983c, d; Wilken 1977). One of the major reasons for this effectiveness is efficient pest management.

Traditional cropping systems have "built-in suppression mechanisms" (Altieri 1983a, b). These include: (a) arrangement of crops, (b) composition and abundance of noncrop vegetation in and around fields, (c) genetic diversity of domesticates and semidomesticates, (d) matching of soil varieties with crop varieties, (e) "natural corridors" between fields, and (f) variation of field sites and long-term management of old fields (Altieri 1985; Denevan 1971; Denevan et al 1984; Parker et al 1984; Posey 1984).

Brown and Marten (1984) point out that crop losses in native fields may be as high as 40%, and such losses are still within the range of losses in modern agriculture using pesticides. One major difference exists: elimination of pesticides from modern systems can produce losses approaching 100% (Schwarz and Klassen 1981), whereas pest damage in traditional agricultural systems almost never exceeds reasonable bounds (Altieri 1985).

The relationship between agricultural polycultures and lower pest incidence is currently under investigation (Altieri and Letourneau 1982; Perrin 1980; Risch et al 1983). Maintenance of a broad genetic base certainly diminishes attacks from host-specific pests (Brush 1982; Gliessman et al 1981; Pimentel and Goodman 1978). A variety of management techniques have been described for different societies. Use of resistant native cultivars, crop rotation, variation in planting times, and use of shade to shelter useful insects are only a few keys to successful traditional agriculture. In Nigeria, for example, okra is planted to divert flea beetles *(Podagria* spp.) from cotton (Perrin 1980). Variations in relative corn and bean planting dates are also used to reduce leafhopper and armyworm damage (Altieri and Letourneau 1982). Many studies detail other management techniques (Altieri 1983a, b, 1985; Bunting 1972; Glass and Thurston 1978; Golob et al 1982; Huis et al 1982; Khan et at 1978; Litsinger et al 1978a, b; Matteson et al 1984; Wilken 1977).

The effects of spatial arrangement, eg. row spacing, are still little known but appear to have significant impact on pest management. Matteson et al (1984) document a significant difference in crop loss between cowpeas *(Maruca testulalis)* planted in intra-rows rather than inter-rows with maize. Kerr and Posey (1984) report that interdispersal of *aria (Calathea aloua)* with tuber crops reduces nematodes and *Collembola*-borne virus attacks in Kayapô fields.

Management of "weeds" is also an important factor in the overall practices of traditional agriculturalists. "Relevant weeds," according to Altieri (1983a, b; 1985), support rich natural enemy fauna that provide alternative prey/hosts, pollen or nectar, or favorable microhabitats unavailable in weed-free fields. Most of what Western agriculturalists would consider "weeds" in a Kayapô field are, in fact, useful semi-domesticates for the Indians (Posey 1986). Altieri and Letourneau (1982) provide examples of cropping systems in which the presence of weeds has enhanced biological control of insect pests.

Western science has only begun to seriously study traditional agricultural science. Yet existing evidence already points to the richness of ideas and data available to interested researchers (Brokenshaw et al 1980; Posey et al 1984; Parker et al 1983). Some laboratories have begun the serious study of toxicological potentials of native pesticides. Results have been promising (Ganjian et al 1983; Kubo and Matsumoto 1984; Kubo et al 1984). Other entomologists, agriculturalists, and ethnoentomologists should devote more attention to the investigation of integrated pest management by native peoples.

MYTHOLOGY, RITUAL, AND "NATURAL MODELS"

Reports of insects in mythology and ritual are widespread. Bushnell (1910) and Mooney (1972) discovered many insects as key figures in the belief systems of Indians of southeastern North America. For the Louisiana Chocktaw, for example, grasshoppers and men were created at the same time and were once brothers; ants were likewise considered as having human ancestors (Bushnell 1910). Ant clans existed in many tribes (Gilbert 1943; Grinnel 1899) and ant people were thought to have been the first to have inhabited the underworld (Bushnell 1910). Water beetles *(Hydrophilidae)* were responsible for the formation of the earth because they had brought up the mud from beneath the waters to form the first dry land (Mooney 1972).

The Cherokee attributed the origin of "Sacred Fire" to the heroic efforts of the water spider, which brought fire on its back while corssing the ocean (Mooney 1972). Diseases and crop pests were cast upon people, according to legend, by Grubworm, who organized his fellow insects to punish humans for their abuse of nature (Posey 1977; Swanton 1928).

Insects also play an important role in Australian aboriginal lore (Meyer-Rochow 1985). Spencer and Gillen (1899) reported 30 insect totems; Berndt and Berndt (1984) provide further evidence of insect-named clan and totemic groupings. One of the major cosmogenic myths of the aborigines refers to the famous witchey grub that served as humankind's first food. Numerous examples of insects in mythology can be found in various compendia (eg., Armstrong 1970; Clausen 1954;; Cowan 1865; Denton 1968; Ealand 1915; Griaule 1961; Kevan 1974, 1979, 1980; Posey 1978, 1980, 1981; Reim 1962; Ritschky 1981; Schimitschek 1968, 1977; Wyman 1973).

Insects are also important components in many ceremonies. The Cherokee shamans employed many insect names in their sacred chants (Kilpatrick and Kilpatrick 1970) and had an elaborate "extraction" ritual to remove disease-causing insects from their patients' bodies (Greenlee 1944; Lawson 1937; Morphi 1932). Fortune-telling rituals used insects as indicators of the future (Mooney 1972). In Brazil, one of the most dramatic rituals is that of the Maue marriage ceremony (Biard 1862). Young boys are submitted to an ordeal of pain in which tocandeiro ants *(Paraponera clavata)*, known for their extremely powerful stings, are placed into a woven mitt (Fig. 2). The boys receive dozens of painful stings when they don the ceremonial glove. When the severe swelling subsides from his arm, a body is considered free to marry.

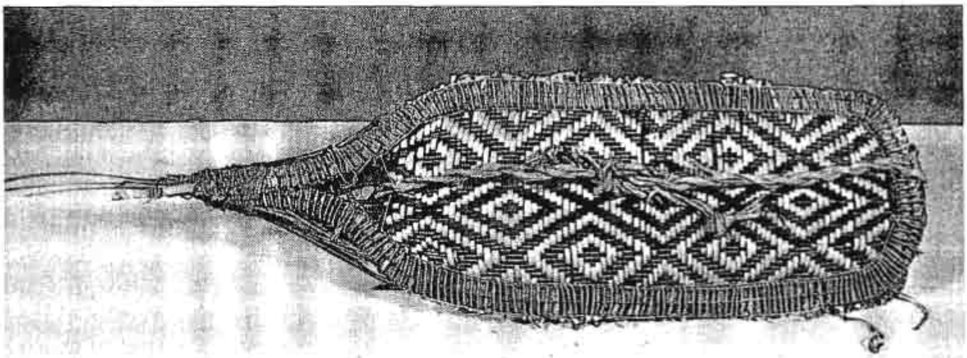

FIG. 2.—Ceremonial mitt used by the Maué Indians of amazonia. Stinging ants are placed in the mitt, which is then worn by boys in the marriage ceremony. Courtesy of the Museu Paulista, São Paulo, Brazil.

Accounts such as those previously related are generally recorded out of cultural context and, consequently, are of limited significance to the folk entomologist. Recent studies (eg., Brown and Chase 1981; Gregor 1983; Luhrmann 1981; Malkin 1956; Posey 1985; Waddy 1982; Wilbert 1981) have attempted to provide a broader cultural framework for the interpretation of insects in myth and ceremony. Natural "models" based upon insect examples and recognized by native peoples themselves have been shown to be useful for the organization of folk scientific data and are significant alternatives to the imposed models of traditional anthropological structuralism and Western science (Posey 1981).

ORAL LITERATURE AND ECOLOGICAL KNOWLEDGE

Oral literature is a major vehicle for ecological information. Santos and Posey (1986) witnessed an old man in the Ilha de Lencois (Brazil) describing his pursuit of a mythological animal. The "plot" of the story could take only three minutes to relate, but the master story-teller kept his audience of local youth spellbound for nearly 45 minutes. Analysis of the folk tale reveals that the minute details used to embellish and add credence to the story is also instruction in local ecology and survival.

Myths are concentrated symbolic codes that transmit cultural information, including social rules and standards of behavior. Ecological information, such as knowledge of animal behavior and "coevolutionary complexes," can also be communicated in myth form (Posey 1983c). Baldus (1937, 1970) recorded Taulipang myths describing the commensal relationships between birds and wasps. Kayapô lore describes commensalsim between stingless bees and acrids (Posey and Camargo 1985).

Mill (1982) points out that widespread stories of "weeping termites" in Brazil reflect folk knowledge of the biological fact that ground nesting termites *(Nasutitermes, Velocitermes,* and *Cortaritermes)* exude droplets of exocrine secretions for chemical defense when disturbed. A Kamaiura myth describes termite nests that glow in the night (Villas-Boas and Villas-Boas 1972). These glowing nests are not superstitious nonsense, but rather recognitions of a natural phenomenon caused by periodic invasions of termite mounds by phosphorescent *Lampyridae* larvae (Redford 1982).

Oral literature has not been sufficiently studied as a transmitter of biological information. This is because of the highly symbolic language of myth and folklore, which is frequently considered as nonsense by those who do not understand the linguistic and cultural codes. Researchers who take the time to learn the language of the societies they study and prepare themselves with training in folkloristics can indeed make a significant contribution to myth interpretation and ethnoentomology.

MISCELLANEOUS TOPICS

Several miscellaneous topics deserve mention. Brief examples will be given to illustrate each topic.

Use of insects as ornaments and decorations—Berlin and Prance (1978), Covarrubias (1971), Kennedy (1943), Lothrap (1964), and Outram (1973) review the importance of insects in art and ornamentation in the New World. Meyer-Rochow (1975) reports the use of green tenebrionid beetles, as well as scarabaeids and buprestids, among the Wahgi Valley people of New Guinea. The Kayapó inherit the right to use irridescent elytra of *Euchroma goliatha* and make elaborate ceremonial hats from meliponine batumen (Posey 1983e). Butterfly wings are commonly used in the Americas for adornment and decoration (Posey 1986). Klots and Klots (1959) report the use of luminous beetles *(Pyrophorus* spp.) to decorate the hair of Indian girls.

Insects as objects of entertainment—Dragonfly catching is a favorite and developed sport in the Banda Islands (Simmons 1976). Butterfly wings are important play objects for Trobriand Island youth (Meyer-Rochow 1985). In Papua New Guinea, large weevils *(Rhynchophorus ferruginius)* are used as musical instruments by letting the human mouth serve as a variable resonance chamber for the wing vibrations of the beetle (Meyer-Rochow 1973). Staged fights between lucanid beetles are reported in Thailand (Meyer-Rochow 1975). Posey and Camargo (1985) report the keeping of stingless bees by the Kayapó Indians purely because of their fascination with social insects. Lenko and Papavaro (1976) give several examples of the keeping of *Pyrophorus* spp. beetles for entertainment, as well as for their light. Dances inspired by insect movements are reported in several North American Indian groups (Bushnell 1910; Gilbert 1943; Schoolcraft 1851; Swanton 1928, 1946).

Insects as indicators—Due to the sensitivity of the head louse to minute changes in body temperatures, some native groups diagnose illness of patients by the presence or absence of lice. Slight fevers can cause an exodus of body lice that indicates oncoming illness (Malinowski 1929; Raths and Biewald 1974). Absence of certain insects can be taken as a sign of environmental pollution (Englehardt 1959), while the presence of other species (such as green flies that are attracted to decaying matter) can indicate unhealthy conditions (Meyer-rochow 1985). Water striders, for example, are indicators of polluted water to the Trobrianders (Meyer-Rochow 1985). Meyer-Rochow (1985) reports how Australian aborigines use the contents of spider webs to indicate the proximity of honey bees. The presence of "mutucas" *(Tabanus)* near river banks indicates the presence of game to indigenous hunters of Brazil (Lenko and Papavaro 1976).

Insects as UFOs—Many tribes in Papua New Guinea report the presence of "flying light spots" in areas where luminescent creatures are not reported by entomologists (Callahan and Mankin 1978). These sightings may be explained by flying insects that enter into electric fields caused by thunderheads; the result is that ordinary insects appear to "emit sparks" (Meyers-Rochow 1985).

Insects and utilitarian concepts—Insects are frequently used as fish bait in preliterate cultures (Kevan 1979). *Nasutitermes* mounds are used for construction material by Brazilian Indians, who prize the natural insulating qualities of the nests extensive galleries (Posey 1979). Nests of *Azteca* ants are buried with newly planted crops to stimulate plant growth (Kerr and Posey 1984). Beeswax and batumen are extensively used for artifact production and paint bases by indigenous tribes of South America (Crane 1979, 1984;

Posey 1978, 1980; Schwarz 1945, 1948). In Papua New Guinea and Northern Australia, ants and maggots are used to clean skeletons and bones. Cantharid beetles are the source of poisons for arrow points for some South American Indians (Meyer-Rochow 1985).

Hallucinogens—Insects have been found as sources of hallucinogens used by some indigenous groups (Meyer-Rochow 1985). It is unclear if the hallucinogenic properties are due to the insects themselves or the plant sources upon which they feed (Blackburn 1976).

Insects and Archaeology—Insects are frequently found in archaeological sites. The presence of seasonal species has been shown to be useful to the archaeologist in determining seasonality of site use and the historic ecological setting (Gilbert and Bass 1967; Hevly 1982; Hevly and Johnson 1974).

Urban Ethnoentomology—A current topic in entomology is the ecology of insects in urban environments (Frankie and Ehler 1978). Studies in this area focus upon the adaptations of insects to the special climatic and edaphic conditions created by intense human manipulation of the natural environment. "Synanthropy" describes the nature of this coexistence with humankind over an extended time (Povolny 1971); a formula for determining the degree of synanthropy has even been developed (Nuorteva 1963). This specialized area of human-insect relationships might also be called "urban ethnoentomology."

HYPOTHESIS GENERATION: THE ETHNOBIOLOGICAL BRIDGE

The interdisciplinary Kayapô project has developed methodological procedures to scientifically test hypotheses generated through its ethnobiological investigations of indigenous ecological knowledge (Posey 1986). Native concepts and beliefs are used by Western scientists as *emic* guides for their research designs (Posey 1983a, 1985). Data collection utilizes indigenous categories for floral and faunal inventories, while ethnoecological concepts (often couched in myth and natural symbols) establish the basis for interdisciplinary dialogue and research. In this manner, indigenous knowledge of biological communities and ecological relationships can be studied; when non-Western notions arise, these are formulated as hypotheses and tested by respective specialists.

Posey (1983b), for example, reports the discovery of nine new species of stingless bees (Meliponinae) through the comparison of Kayapô and Western taxonomic systems. Posey and Camargo (1985) record the utility of Indian knowledge about bee behavior in the development of studies in areas little known to ethnoentomologists, such as: differences in odor characteristics, swarming behavior, flight patterns, and habitat choices between or within meliponine species. They also propose scientific investigations based on indigenous knowledge of bee species distribution in relation to ecological zones and habitat sharing by certain species clusters. Indian ideas of acrid commensalism and use of odor trails by species for which such activity is unreported have also spurred further studies by entomologists of stingless bee behavior.

Overal and Posey (1986) have effected a large inventory of arthropod agricultural pests based on Indian information and confirmed by field collections. They also report the development of research into the highly effective control of agricultural pests in indigenous gardens through inter-cropping, use of trap crops and natural predators. The Indians attribute much of this natural control to predatory ants, wasps, and termites, all of which are glorified in Kayapô myth and song. Roles of these insects in crop pest control are being investigated following indigenous guidelines.

Kerr and Posey (1984) report how the Kayapô utilize *Azteca* spp. ants to repel leaf-cutting sauva (*Atta* spp.). Likewise, Kerr and Posey (1986) report the indigenous use of several natural pesticides and call for their testing by Western science. At least in the case of *Azteca* spp., Overal and Posey (1986) report very positive results from scientific tests to determine their effectiveness in the protection of Amazonian citrus.

Anderson and Posey (1986) and Posey (1984) report the intentional planting of certain plant species by Indians to attract bees. Such knowledge can be helpful in the investigation of tropical pollination and aid in the improvement of apiculture.

Many bee species are thought by the Kayapó to have important medicinal properties (Posey 1983e). Although almost practically unknown by pharmacologists they need to be investigated for their effectiveness and potential for a natural pharmacopeia (Elisabetsky and Posey 1986).

These are but a few examples from a single ethnobiological project of how indigenous knowledge can stimulate new ideas for Western science. No researcher is expected to accept *prima facie* all native beliefs. Much indigenous knowledge, as we have already seen, is highly symbolic and difficult for even the most experienced anthropologist to interpret; however, nothing can be dismissed by the ethnobiologist no matter how ridiculous it may intially sound. The most seemingly ludicrous ideas today may offer the greatest insights tomorrow when their symbols are finally decoded.

Refusal by Western scientists to study native beliefs is, after all, not a very scientific attitude. It is much more scientific to test the validity of native observations through the testing of hypotheses generated by ethnobiological study.

CONCLUDING REMARKS

Knowledge, classification, and use of insects in human societies is diverse but relatively unstudied in a systematic manner. Lack of anthropological and linguistic training by entomologists—and entomological training by anthropologists and linguists—hampers ethnoentomological research. A true science of ethnoentomology will not develop until researchers have sufficient expertise in all three fields to investigate the native *emic* view of "natural worlds."

This situation does not prevent the elaboration of studies in cultural entomology that attempt to investigate insect importance in literate societies. Nor does it inhibit important research into the potential uses of insects as foods and medicines. Indeed, insects have played a significant role in human history and may be even more important in the future. Whether as protein sources in space flight or as key elements in integrated biological pest control, insects will continue to be studied and manipulated for human welfare.

From the theoretical side, folk biological studies can discover "natural models" used by other peoples to define their own world in their own terms. Instead of imposing paradigms of anthropological structuralism and Western science upon non-Western peoples, we must learn to elicit and organize our data within the cognitive bounds of the societies we study.

Folk systems of knowledge have in most cases developed for many millenia and are frequently more ancient than Western science. They reflect the diversity of ways in which the natural world can be ordered and provide detailed information of ethology, ecological communities, useful species, and biological diversity. Folk knowledge can also serve to generate new ideas and hypotheses that can be investigated and tested with the rigorous controls of occidental science.

Studies of folk knowledge as outlined in this paper offer a powerful "intellectual bridge" between different peoples. Understanding the sciences of other cultures enriches Western science and provides the philosophical bases for the understanding and appreciation of other peoples *on* and *in* their own terms.

ACKNOWLEDGEMENTS

I wish to thank Dr. Murray Blum for his many years of encouragement of my ethnoentomological research. Special thanks to Dr. Charles Hogue, Dr. H. Weidner, and Dr. Nelson Papavaro for their assistance in acquiring useful materials for the preparation of this paper. I am grateful to Daniel Linger, Dr. Warwick E. Kerr, and an anonymous reviewer for their useful criticisms and comments on this paper, and to Carol Jones for her typing and proofing of the final manuscript.

LITERATURE CITED

AESCHLIMANN, J. P. 1982. Du role des insectes dans l'alimentation humaine. Mitt. entomol. ges. 32(4): 99-103.

ALDRICH, J. M. 1921. *Coloradia pandora* Blake, a moth of which the caterpillar is used as food by the Mono Lake Indians. Ann. Entomol. Soc. Am. 14:36-38.

ALTIERI, M. A. 1983a. Agroecology: The Scientific Basis of alternative agriculture. Univ. California Div. Biol. Control, Berkeley. 85 pp.

______________. 1983b. Pest management technologies for peasants: a farming systems approach. Crop Prot. 3:87-94.

______________. 1985. Developing pest management strategies for small farmers based on traditional knowledge. Dev. Anthro. Network 3(1): 13-18.

______________, and D. K. LETOURNEAU. 1982. Vegetation management and biological control in agroecosystems. Crop Prot. 1:405-30.

ALVERSON, H. 1984. The wisdom of tradition in the development of dryland farming: Botswana. Hum. Organ. 43:1-8.

ANDERSON, A. B. and D. A. POSEY. 1986. Manejo de campo-cerrado pelos indios Kayapõ. Bol. Museu Goeldi. In press.

ARAUJO, A. M. 1961. Medicina rustica. Serie Brasiliana, Vol. 300. Cia. Ed. Nac., São Paulo. 205 pp.

ARMSTRONG, E. A. 1970. Insects. Man Myth Magic 52:1445-1451.

ARNDT, W. 1923. Bemerkungen uber die rolle der insekten in Arzneischatz der alten kulturvolker. Dtsch. Entomol. Z. 1923:553-570.

BALDUS, M. 1937. Ensaios de etnologia brasileira. Series Brasiliana, Vol. 101. Cia. Ed. Nac., São Paulo. 235 pp.

______________. 1970. Tapirape, tribo tupi no Brasil Central. Series Brasiliana, Vol. 17. Cia. Ed. Nac., São Paulo. 210 pp.

BARRETT, S. A. 1925. The Cayapa Indians of Ecuador. Indian Notes and Monographs, No. 40. Mus. Am. Indian. New York. 180 pp.

BATES, H. W. 1862. Description of a remarkable species of singing cricket. J. Entomol. 1:474-477.

BENNETT, C. F., Jr. 1964. Stingless-bee keeping in western Mexico. Geogr. Rev. 54(1):85-92.

______________. 1965. Beekeeping with stingless bees in western Panama. Bee World 46(1):23-24.

BERGIER, E. 1941. Insectes Comestibles e Peuples Entomophages. Impr. Rullière Frères, Avignon. 229 pp.

BERLIN, B. and G. T. PRANCE. 1978. Insects galls and human ornamentation: Ethnobotanical significance of a new species *Licania* in Amazonas, Peru. Biotropica 10:81-86.

BERNDT, R. M. and C. H. BERNDT. 1964. The World of the First Australians. Ure Smith, Sydney. 238 pp.

BIARD, A. F. 1862. Deux Annees au Brésil. Hachette, Paris. 197 pp.

BLACKBURN, T. 1976. A query regarding the possible hallucinogenic effects of ant ingestion southcentral California. J. California Anthr. 3:78-81.

BODENHEIMER, F. S. 1951. Insects as Human Food: A Chapter in the

LITERATURE CITED (continued)

Ecology of Man. Junk, The Hague. 352 pp.

BROK ENSHA, D. W., D. M. WARREN, WERNER, O. WERNER, eds. 1980. Indigenous Knowledge Systems and Development. Maryland Univ. Press America, Lanham. 435 pp.

BROWN, C. H. and P. K. CHASE. 1981. Animal classification in Juchitan, Zapotec. J. Anthropological Res. 37:61-70.

BROWN, B. J. and G. G. MARTEN. 1984. The Ecology of Traditional Pest Management in Southeast Asia. Work. Pap., East-West Center, Hawaii, 23 pp.

BRUSH, S. B. 1982. The natural and human environment of the central Andes. Mt. Res. Dev. 2:14-38.

BULMER, R. N. H. 1968. Worms that croak and other mysteries of Karam natural history. Mankind 6:621-639.

BUNTING, A. H. 1972. Pests, population and poverty. Trop. Sci. 14:37-50.

BUSHNELL, D. I. 1909. The Choctaw of Bayou Lacomb, St. Tammany Parish, Louisiana. *In* Bureau of American Ethnology, Bul. 48. Smithson Inst., Washington, D.C.

______________. 1910. Myths of the Louisiana Chocktaw. Am. Anthropol. 12:526-535.

BUSHVINE, J. R. 1976. Insects, Hygiene and History. Athlone, London. 262 pp.

CALLAHAN, P. S. and R. W. MANKIN. 1978. Insects as unidentified flying objects. Appl. Opt. 17:3355-3360.

CALVERT, C. C., R. D. MARTIN and N. O. MORGAN. 1969. House fly pupae as food for poultry. J. Econ. Entomol. 62:938-939.

CARON, D. M. 1978. Insects and human nutrition. Ame. Bee J. 118(6):388-389.

CARVALHO, J. C. M. 1951. Relacões entre os indios do alto Xingú e a fauna regional. Publ. Avulsa. Mus. Nac., Rio de Janeiro, 7:1-32.

CATLEY, A. 1963. Notes on insects as food for native peoples in Papua New Guinea. Trans. Papua New Guinea Sci. Soc. 4:10-12.

CAUDEL, A. N. 1916. An economic consideration of Orthoptera directly affecting man. Proc. Entomol. Soc. Wash. 18:84-92.

CHAGNON, N. 1968. Yanomamo: The fierce people. Holt, Rinehart, and Winston, New York. 135 pp.

______________. 1973. Yanomamo. Pp. 234-247 *in* Peoples of the Earth, (E. E. Evans-Pritchard, eds.). Danbury, Verona.

CHAMBERS, D. L. 1977. Quality control in mass rearing. Ann. Rev. Entomol. 22:289-308.

CHOOVIVATHANAVANICH, P., P. SUWANPRATEEP, N. KATHAVICHITRA. 1970. Cockroach sensitivity in allergic Thais. Lancet 2:1362-1363.

CLAUSEN, L. W. 1954. Insect Fact and Folklore. Macmillan, New York. 194 pp.

CLOUDSLY-THOMPSON, J. L. 1976. Insects and history. St. Martins, New York. 242 pp.

COIMBRA, C., Jr. 1984. Estudos de ecologia humana entre os Surui do parque indigena Aripunã, Rondonia. 1. O uso de larvas de Coleópteros (Bruchidae e Curculionidae) na alimentacão. Rev. Bras. Zool. 2(2):35-47.

CONCONI, J. R. E. 1977. Valor nutritovo de ciertos insectos comestibles de México y lista de algunos insectos comestibles del mundo. An. Inst. Biol. Univ. Nacional. Auton. Méx. 48(1):165-185.

______________. 1982. Los Insectos Como Fuente de Proteinas en el Futuro. Limusa, México, D. F. 144 pp.

______________, J. M. P. MORENO, and O. M. GONZALES. 1981. Digestibilidad en vitro de algunos insectos comestibles en México. Folia Entomol. Mex. 49:141-154.

______________, J. M. P. MORENO, C. M. MAYAUDON, F. VALDEZ,

LITERATURE CITED (continued)

and M. A. PEREZ, et al. 1984. Protein content of some edible insects in Mexico. J. Ethnobiol. 4(1):61-72.

CONKLIN, H. C. 1973. Folk Classification: A topically arranged bibliography of contemporary and background references through 1971. Yales Univ. Press, New Haven.

COOPER, J. I. and T. W. TINSLEY. 1978. Some epidemiological consequences of drastic ecosystem changes accompanying exploitation of tropical rain forest. Terre Vie 32(2):221-240.

COVARRUBIAS, M. 1971. Indian Art of Mexico and Latin America. A. A. Knopf, New York. 386 pp.

COWAN, F. 1865. Curious Facts in the History of Insects. J. B. Lippincott, Philadelphia. 405 pp.

CRANE, E., ed. 1979. Honey: A Comprehensive Survey. Intl. Bee Res. Assn. Gerrads Cross, Buckshire, England. 624 pp.

CRANE, E. 1984. The Archaeology of Beekeeping. Duckwort, London. 611 pp.

CROSBY, A. W., Jr. 1972. The Columbian Exchange: Biological and Cultural Consequence of 1492. Greenwood, Westport. 286 pp.

CURRAN, C. H. 1939. On eating insects. Nat. Hist. 613:84-89.

CURRAN, C. H. 1937. Insect lore of the Aztecs revealing early acquaintanceship with many of our agricultural pests and therapeutic measures against so currently prominent a creature as the black widow spider. Nat. Hist. 39:196-203.

DAMMERMAN, K. W. 1929. The Agricultural Zoology of the Malay Archipelago. J. H. Buxy. Amsterdam. 473 pp.

DAOUST, M. V. 1858. On some eggs of insects employed as human food, and giving rise to the formation of Oolites in Laucustrine limestone in Mexico. Ann. Mag. Nat. Hist. 2:78-80.

DEFOLIART, G. R. 1975. Insects as a source of protein. Bull. Entomol. Soc. Am. 21(3):161-163.

DENEVAN, W. M. 1971. Campa Subsistence in the Gran Pajonal, Eastern Peru. Geogr. Rev. 61(4):496-518.

DENEVAN, W., J. TREACH, J. ALCORN, C. PADOCH, J. DENSLOW, and J. PAITAN. 1984. Indigenous agroforestry in the Amazon: Bora Indian management of swidden fallows. Interciencia 9(6):346-357.

DENTAN, R. K. 1968. Notes on Semai ethnoentomology. Malay. Nat. J. 21(1):17-28.

DOBYNS, H. 1966. Estimating aboriginal American population. Curr. Anthropol. 7:395-416.

DUFOUR, R. A. 1981. Insects: A Nutritional Alternative. Dep. Med. Pub. Affairs, George Washington Univ. Med. Cent., Washington, D.C. 64 pp.

EALAND, C. A. 1915. Insects and Man. Richards. London. 343 pp.

EFFLATON, B. 1929. The development of entomological science in Egypt. Trans. 1st. Int. Congr. Entomol, 1928. 2:737-742.

EGGER, K. 1981. Ecofarming in the tropics—Characteristics and potentialities. Plant Res. Dev. 13:96-106.

ENGELHARDT, W. 1959. Was lebt in Tümpel, Bach und Weiher? Verlagshdlg. Stuttgart. 387 pp.

ELIZABETSKY, E. and D. A. POSEY. 1986. Conceito de animais com os indios Kayapô. Rev. Bras. Zool. in press.

ESSIG, E. O. 1931. A History of Entomology. Macmillan. New York. 1029 pp.

__________. 1934. The value of insects to the California Indians. Sci. Mon. 38:181-186.

FLOERICKE, K. 1922. Huechrecken und libellen. Kosmos. Stuttgart. 235 pp.

FRANKIE, G. W. and L. E. EHLER. 1978. Ecology of insects in urban environments. Ann. Rev. Entomol. 23:367-388.

LITERATURE CITED (continued)

GANJIAN, I., I. KUBO and P. FLUDZINSKI. 1983. Insect antifeedant elemanolide lactones from *Vernonia amygdalina*. Phytochemistry 22(11): 2525-2526.

GIACONE, A. 1949. Os Tucanos e outras tribos de Rio Uaupés affluente do Negro-Amazonas. Imprensa Off. Estado. São Paulo. 135 pp.

GILBERT, W. H. 1943. The Eastern Cherokee. In Bureau of American Ethnology, Bull. 133, 169-413. Smithson. Inst. Washington, D.C.

GILBERT, B. M. and W. H. BASS. 1967. Seasonal dating of burials from the presence of fly pupae. Am. Antiq. 32(4):534-535.

GLASS, E. H. and H. D. THURSTON. 1978. Traditional and modern crop protection in perspective. Bioscience 28(2):109-115.

GLIESSMAN, S. R., E. R. GARCIA and A. M. AMADOR. 1981. The ecological basis for the application of traditional agricultural technology in the management of tropical agroecosystems. Agroecosystems 7:173-185.

GLOCK, J. 1891. Die symbolik der bienen und ihrer produkte in sage, dichtung, kultus, kunst und Bräuchen der Völker. Heidelberg. 411 pp.

GOLOB, P., J. MWAMBULA, V. MHANG and F. NGULUBE. 1982. The use of locally available materials as protectants of maize grain against insect infestations during storage in Malawi. J. Stored Prod. Res. 18:67-74.

GORHAM, J. R. 1975. Filth in foods: Implication for health. J. Milk Food Technol. 38:409-418.

_______________. 1976. Insects as food. Bull. Soc. Vector Ecol. 3:11-16.

_______________. 1976. A rational look at insects as food. FDA Guidelines 5:231-239.

_______________. 1979. The significance for human health of insects in food. Annu. Rev. Entomol. 24:209-224.

GREENLEE, R. 1944. Medicine and curing practices of the modern Florida Seminoles. Am. Anthropol. 46:897-912.

GREGOR, T. 1983. Dark dreams about the white man. Nat. Hist. 8 pp.

GRIAULE, M. 1961. Classification des insectes chez les Dogon. J. Soc. Afr. 31:7-71.

GRINNEL, G. B. 1899. The butterfly and the spider among the Blackfoot. Am. Anthropol. 1:194-196.

GUDGER, E. W. 1925. Stitching wounds with the mandibles of ants and beetles. J. Am. Med. Assoc. 84(24): 1861-1864.

HAGAN, H. 1863. Die insektennamen der Tupi sprach. Stettiner Entomol. Ztg. 24:252-259.

HARE, R. 1954. Pomp and Pestilence. Gollancz. London. 224 pp.

HARLAN, J. R. 1976. The plants and animals that nourish man. Sci. Am. 253(3):89-97.

HARPAZ, I. 1973. Early entomology in the Middle East. *In* History of Entomology, (R. F. Smith, ed.), Palo Alto, California. Annual Reviews. 456 pp.

HENDRICKS, P. K. 1941. Cultivo de abejas indigenas en el Estado de Guerro. Méx. Antiguo 5:365-373.

HEVLY, R. H. 1982. Analysis of flotation samples from the Coronado transmission line corridor. *In* The Specialist Volume: Biocultural Analysis, Coronado Ser. 4, Paper 23. Museum of Northern Arizona, Flagstaff. 277 pp.

_______________ and C. D. JOHNSON. 1974. Insect remains from prehistoric pueblo in Arizona. Pan-Am. Entomol. 50(3):307-308.

HITCHCOCK, S. W. 1962. Insects and Indians of the Americas. Bull. Entomol. Soc. Am. 8:181-187.

HOFFMAN, W. E. 1947. Insects as human food. Proc. Entomol. Soc. Wash. 49:223-237.

HOGUE, C. L. 1980. Commentaries in cultural entomology—definition of cultural entomology. Entomol. News 91(2):33-36.

LITERATURE CITED (continued)

HOLT, V. M. 1885. Why Not Eat Insects? E. W. Classey. Middlesex, England. 325 pp.

HOSEN, H. W. 1980. Factors associated with the attribution of human traits to nonhumans. J. Soc. Psychol. 112(1):161-162.

HUIS, A. VAN, R. S. NAUTA and M. E. VULTO. 1982. Traditional pest management in maize in Nicaragua: A Survey. Meded. Landbouwhogesch. Wageningen 82-86, pp. 43.

KATTER, F. 1883. Die canthariden spec. Meloe als Meilmitel der Tollwurth. Entomol. Nachr. 9:156-183.

KENNEDY, C. H. 1943. A dragonfly nymph design in Indian pottery. Ann. Entomol. Soc. Ame. 36:190-191.

KERR, W. E. and D. A. POSEY. 1984. Nova informacão sobre a agricultura dos Kayapó. Interciencia 9(6):392-400.

______________. 1986. "Um Cipó" que mata abelha. Rev. Bras. Zool. in press.

KEVAN, D. K. 1974. The Land of Grasshoppers. Lyman Entomol. Mus. Ste-Anne-de-Bellevue, Quebec. 328 pp.

KEVAN, K. M. 1979. The place of grasshoppers and crickets in Amerindian cultures. Proc. of the 2nd Triennial Meet. Pan-Am. Acridol. Soc. 74 pp.

KEVAN, D. K. 1980. Grigs, graces, graphics and graffiti. Metaleptea 2(2): 55-72.

KHAN, M. M., D. RAJAGOPAL, and P. HANUMAPPA. 1978. Plant protection practices and problems of chilly growers of Kolar District. Mysore J. Agric. Sci. 12:159-163.

KILPATRICK, J. and A. KILPATRICK. 1970. Notebook of a Cherokee Shaman. Smithson. Cont. Anthropol. 2(6). Smithson Inst., Washington. 120 pp.

KLOTS, A. B. and E. B. KLOTS. 1959. Insekten. München-Zürich: Droemersch Verlagsanst. 367 pp.

KNORTZ, K. 1910. Die insekten in sage, sitte, und literatur. Annaberg/Sachsen. Graeser. 151 pp.

KOK, R. 1983. The production of insects for human food. J. Can. Inst. Food Sci. Technol. 16(1):5-18.

KUBO, I. and T. MATSUMOTO. 1984. Abyssinin, a potent insect antifeedant from an African medicinal plant, *Bersame abyssinica*. Tetrahedron Lett. 25(41):4601-4604.

KUBO, I., T. MATSUMOTO, J. A. KLOCKE and T. KAMIKAWA. 1984. Molluscicidial and insecticial activities of isobutylamides isolated from *Fagara macrophylla*. Experientia 40:340-341.

LAUFER, B. 1927. Insect-musicians and cricket champions of China. Field Mus. Anthropol. Leafl. 22. Field Mus. Nat. Hist. Chicago. 27 pp.

LAWSON, J. 1937. History of Carolina. Richmond, Virginia. 367 pp.

LENKO, K. and N. PAPAVARO. 1979. Insectos no Folclore. Cons. Estad. Artes Cienc. Hum. São Paulo. 518 pp.

LIEBRECHT, F. 1886. Tocandyrafestes. Z. Ethnobiol. 18:350-352.

LITSINGER, J. A., E. C. PRICE and R. T. HERRERA. 1978a. Filipino farmer use of plant parts to control rice insect pests. Int. Rice Res. News 3(5):15-16.

______________. 1978b. How the farmers in three provinces control crop pests. Greenfields 8(8):6-16.

______________. 1980. Small farmer pest control practices for rainfed rice, corn, and grain legumes in three Philippine provinces. Philipp. Entomol. 4:65-86.

LOTHRAP, S. K. 1964. Treasures of Ancient America. Geneva:SKIRA. 329 pp.

LUHRMANN, T. M. 1981. Bee as metaphor: Psychodynamic tensions in Maya culture. Unpubl. B.A. thesis, Harvard Coll., Cambridge, Massachusetts. 75 pp.

MACHARGUE, J. S. 1917. A study of proteins of certain insects with reference to their value as food for poultry. J. Agric. Res. 19:633-637.

LITERATURE CITED (continued)

MCKEOWN, K. C. 1944. Insect Wonders of Australia. Angus & Robertson, Sydney. 256 pp.

MCNEILL, W. H. 1976. Plagues and People. Anchor, Garden City. 369 pp.

MALINOWSKI, B. 1929. The Sexual Life of Savages in Northwestern Melanesia. H. Ellis, New York. 437 pp.

MALKIN, B. 1956. Seri ethnozoology: A preliminary report. Davidson J. Anthropol. 2:73-83.

MARSHALL, W. 1894. Neueröffnetes, wundersames Arzenei-Kästlein. Leipsig. 127 pp.

MATTESON, P. C., M. A. ALTIERI, and W. C. GAGNE. 1984. Modification of small farmer practices for better pest management. Ann. Rev. Entomol. 29:383-402.

MEGGITT, M. J. 1962. Desert People: A study of the Walbri Aborigines of Central Australia. Angus & Robertson, Sydney. 298 pp.

METRAUX, A. 1948a. The hunting and gathering tribes of the Rio Negro Basin. *In* Handbook of South American Indians, 3:816-67. Smithson. Inst., Washington, D.C.

_______________. 1948b. Tribes of the Middle and Upper Amazon River. *In* Handbook of South American Indians, 3:668-712. Smithson. Inst., Washington, D.C.

MEYER-ROCHOW, V. B. 1973. Edible insects in three different ethnic groups of Papua New Guinea. Am. J. Clin. Nutr. 26:673-677.

_______________. 1975a. Can insects help to ease the problem of world food shortage? Search 6(7):261-262.

_______________. 1975b. Local taxonomy and terminology for some terrestrial arthropods in five different ethnic groups of Papua New Guinea and Central Australia. J. Rev. Soc. West Australia 58:15-30.

_______________. 1976. The use of insects as human food. Food & Nutr. 33:151-152.

_______________. 1985. The diverse uses of insects in traditional societies. J. Ethnommed. In press.

MILL, A. E. 1982. Amazon termite myths: Legends and folklore of the Indians and Caboclos. Trans. R. Entmol. Soc. London 6(2):214-217.

MILLER, J. A. 1981. Space gardening. Sci. News Lett. 119:330-334.

MODELL, M. 1977. Sustaining life in a space colony. Technol. Rev. 79(8): 36-43.

MONTGOMERY, B. F. 1959. Arthropods and ancient man. Bull. Entomol. Soc. Am. 5:68-70.

MOONEY, J. 1972. Myths of the Cherokee and Sacred Formulas of the Cherokee. Reprinted from the seventh and ninteenth Annual Reports of the Bureau of American Ethnology. Elder Bookseller, Nashville. 426 pp.

MORPHI, F. J. A. 1932. History of the Province of Texas. 156 pp.

NOGEIRA-NETO, P. 1970. A Criacão de Abelhas Indigenas sem Ferrão (Meliponinae). Tecnapis, São Paulo. 307 pp.

NORDESKIÖLD, E. 1929. L'apiculture indienne. J. Soc. Americanistes 21(1):169-182.

NUORTEVA, P. 1963. Synanthropy of blowflies in Finland. Annu. Entomol. Fenn. 29:1-49.

OKA, I. N. and D. PIMENTEL. 1974. Corn susceptibility to corn leaf aphids and common corn smut after herbicide treatment. Environ. Entomol. 2(6):911-915.

OUTRAM, I. 1973. Insects in the art and myth of the northwest coast Indians. Bull. Entomol. Soc. Can. 5(1):20-26.

OVERAL, W. L. and D. A. POSEY. 1986. O Controle Naturale nas Rocas Kaiapó. Rev. Braz. Zool. In press.

PARENT, G., F. MALAISSE and C. VERSTRAETEN. 1978. Les miels dans la foret claire du shaba méri-

LITERATURE CITED (continued)

dional. Bull. Rech. Agron. Gembloux 13(2):161-176.

PARKER, E., D. A. POSEY, J. FRECHIONE and L. F. DA SILVA. 1983. Resource exploitation in Amazonia: Ethnoecological examples from four populations. Ann. Carnegie Mus. 52 (Art 8):163-203.

PERRIN, R. M. 1980. The role of environmental diversity in crop protection. Protopathic Ecol. 2:77-114.

PIMENTEL, D. 1971. World food crisis: Energy and pests. Bull. Entomol. Soc. Am. 22:20-26.

__________ and N. GOODMAN. 1978. Ecological basis for the management of insect populations. Oikos 30:422-437.

__________, TERHUNE, W., DRITSCHILO, D. GALLAHAN and N. KINNER. 1977. Pesticides, insects in foods, and cosmetic standards. BioScience 27(3):178-185.

POSEY, D. A. 1976. Entomological considerations in southeastern aboriginal demography. J. Ethnohist. 23(2):147-160.

__________. 1977. An ethnoentomological perspective of the southeastern Indian belief system. Hum. Mosaic 11(1):1-9.

__________. 1978. Ethnoentomological survey of Amerind groups of lowland South America. Florida Entomolo. 61:225-229.

__________. 1979. Ethnoentomology of the Kayapô Indians of Central Brazil. Unpubl. Ph.D. dissert., Univ. Georgia, Athens.

__________. 1979. Kayapô controla inseto com uso adequado do ambiente. Rev. Atual. Indig. 3(14):47-56.

__________. 1980. Consideraciones etnoentomologicas sobre los grupos amerindios. Am. Indig. 40(1):105-120.

__________. 1981. Wasps, warriors, and fearless men: Ethnoentomology of the Kayapô Indians of central Brazil. J. Ethnobiol. 1:165-174.

__________. 1983a. Ethnomethodology as an *emic* guide to cultural systems: The case of the insects and the Kayapô Indians of Amazonia. Rev. Bras. Zool. 1(3):135-144.

__________. 1983b. Folk apiculture of the Kayapô Indians of Brazil. Biotropica 15(2):154-158.

__________. 1983c. Indigenous knowledge and development: An ideological bridge to the future. Ciênc. Cul. 35(7):877-894.

__________. 1983d. Indigenous knowledge and development of the Amazon. Pp. 135-144 *in* The Dilemma of Amazonian Development, (E. Moran, ed.). Westview. Boulder, Colorado.

__________. 1983e. Keeping of stingless bees by the Kayapô Indians of Brazil. J. Ethnobiol. 3(1):63-73.

__________. 1983f. The importance of bees to an Indian tribe of Amazonia. Fla. Entomol. 65(4):452-458.

__________. 1984. A preliminary report on diversified management of tropical forest by the Kayapô Indians of the Brazilian amazon. Ethnobotany in the Neotropics: Advances in Ecomonic Botany 1:112-126.

__________. 1985. Hierarchy and utility in a folk biological taxonomic system: Patterns in classification of Arthropods by the Kayapô Indians of Brazil. J. Ethnobiol. in press.

__________. 1986. Etnoentomologia dos indios Amazonicos. *In* Suma Brasileria de Etnologia. Rio de Janeiro: FINESP. in press.

__________ and J. M. F. Camargo. Additional notes on beekeeping of Meliponinae by the Kayapô Indians of Brazil. Ann. Carnegie Mus. in press.

__________, J. FRECHIONE, J. EDDINS and L. FRANCELINO DA SILVA. 1984. Ethnoecology as Applied Anthropology in Amazonian Development. Human Organization 43(2):95-107.

LITERATURE CITED (continued)

POVOLNY, D. 1971. Synanthropy. *In* Flies and Disease, (B. Greenberg, ed.). Princeton Univ., Princeton. 856 pp.

RAMIREZ, J. P., P. ARROYO and A. CHAVEZ. 1973. Aspectos socioeconómicos de los alimentos y la alimentación en México. Rev. Comer. Ext. del Bco. de Comer. Ext. 1:675-690.

RANSOME, H. M. 1937. The Sacred Bee in Ancient Times and Folklore. George Allen & Unwin London. 285 pp.

RATHS, A. and D. BIEWALD. 1974. Tiere im Experiment. Aulis Verlag Deubner & Co., Köln. 316 pp.

READ, B. E. 1935. Insect drugs. Peking Nat. Hist. Bull. 94:8-85.

REDFORD, K. H. 1982. Prey attraction as a possible function of bioluminescence in the larvae of *Pyrearinus termitilluminans* s (Coleoptera: Elateridae). Rev. Bras. Zool. 1(1):31-34.

______________. 1986. Insects as food for humans: Some cautionary comments. J. Ethnobiol. in press.

______________ and J. G. DOREA. 1984. The nutritional value of invertebrates with emphasis on ants and termites as food for mammals. J. Zool. London 203:395-395.

REED, A. W. 1965. The flies and the bees. Pp. 40-41 *in* Aboriginal Fables and Legendary Tales. Reed, Sydney. 144 pp.

REIM, H. 1962. Die insektennahrung der Australischen ureinwohner. Academie Verlag, Berlin. 224 pp.

RISCH, S. J., D. ANDOW and M. A. ALTIERI. 1983. Agroecosystem diversity and pest control: Data, tentative conclusions, and new research directions. Environmental Entomol. 12:625-629.

RITCHIE, C. 1979. Insects, the creeping conquerors and human history. Soc. Sci. 54(2):122-132.

ROHEIM, G. 1974. Children of the Desert: The Western Tribe of Central Australia. Basic Books, New York. 309 pp.

RUDDELL, K. 1973. The human use of insects: Examples from the Yukpa. Biotropica 5(2):94-101.

RUTSCHKY, C. W. 1981. Arthropods in the lives and legends of the Pennsylvania Indians. Mels. Entomol. Ser. 30:39-42.

SANTOS, P. B. and D. A. POSEY. 1986. Conceitos de saúde, adoecer, vura e morte em relacão as plantas medicinais e o aparecimento de D. Sebastião, Rei Messianico, na ilha de Lencois, Maranhão. Ciencia e Cultura in press.

______________ and C. COIMBRA, JR. 1984. Criacãeo e comercializacão de larvas de *Hermetia illucens* (Diptera: Stratiomydae) em uma comunidade do Distrito Federal. Cienc. Cult. 36(12):2211-2215.

SCARBOROUGH, J. 1979a. On the history of early entomology chiefly Greek and Roman, with a preliminary bibliography. Melsheimer Entomol. Serv. 26:17-27.

______________. 1979b. Nicander's toxicology: spiders, scorpions, insects, and myriapods. P. 1. Pharm. Hist. 21(1):3-34.

______________. 1979c. Nicander's toxicology: spiders, scorions, insects and myriapods. P. 2. Pharm. Hist. 21(2):73-92.

______________. 1981. Ancient medicine: Some recent books. Clio Med. 16(2/3):141-149.

SCHIMITSCHEK, E. 1968. Insekten abs nahrung, in Brauchtum, Kukt, und Kultur, 2nd ed. Pp. 1-62 *in* Kukenthal's Handbook der Zoologie (J. C. Helmcke, D. Starck, R. Wekmuth, eds.). Walter de Gruyter. Berlin.

______________. 1977. Insekten in der bildenden Kunst im Wandel der

LITERATURE CITED (continued)

Zeiten in psychogenetischer Sicht. Veroff. Naturhist. Mus. Wein. 14:119 ff.

SCHOOLCRAFT, H. R. 1851. Historical and Statistical Information Respecting the History, Condition, and Prospects of the Indian Tribes of the United States. Bur. Indian Affairs, Philadelphia. 485 pp.

SCHWARZ, H. F. 1945. The wax of stingless bees (Meliponidae) and the uses to which it has been put. J. New York Entomol. Soc. 53:137-139.

______________. 1948. Domestication of stingless bees and rites connected with bee culture. Bull. Am. Mus. Nat. Hist. 90:142-160.

SCHWARZ, P. M. and W. KLASSEN. 1981. Estimate of losses caused by insects and mites to agricultural crops. *In* CRC Handbook of Pest Management in Agriculture. (D. Pimentel, ed.). CRC Press, Boca Raton.

SINGEREST, H. E. 1951. Civilization and Disease. Cornell Univ. Press, Ithaca, New York. 255 pp.

SILOW, C. A. 1976. Edible and Other Insects of Mid-western Zambia. Occ. Pap. 5. Inst. Allm. Jamforand Etnogr., Uppsala.

______________. 1983. Notes on Ngangela and Kkoya ethnozoology, ants, and termites. Etnol. Stud. 36:1-177.

SIMMONS, P. 1976. A specific visual response in dragonflies. Odonatologica 5:285.

SKINNER, A. 1910. The use of insects and other invertebrates as food by North american Indians. J. New York Entomol. Soc. 18:264-267.

SMITH, K. G. V., ed. 1973. Insects and Other Arthropods of Medical Importance. Br. Mus. Nat. Hist. London. 561 pp.

SPENCER, B. and F. J. GILLEN. 1899. The Native Tribes of Central Australia. Macmillan, London. 387 pp.

STEWARD, J. and A. METRAUX. 1948. The Peban tribes. *In* Handbook of South American Indians 3:816-867. Smithson. Inst. Washington, D.C.

SWANTON, J. R. 1928. Religious beliefs and medical practices of the Creek Indians. Ann. Rep. Bur. Am. Ethnol. No. 42:437-672.

______________. 1946. The Indians of the southeastern United States. Bur. Am. Ethnol. Bull. 137. Washington, D.C. 445 pp.

TAYLOR, R. L. 1975. Butterflies in My Stomach: Or Insects in Human Nutrition. Woodbridge, Santa Barbara. 224 pp.

TEOTIA, J. S. and B. F. MILLER 1974. Nutritive content of house fly pupae and manure residue. Br. Poult. Sci. 15:177-182.

THRESH, J. M. 1982. Cropping practices and virus spread. Ann. Rev. Phytopathol. 20:193-218.

TIHON, L. 1946. A propos des termites au point de vue alimentaire. Bull. Agric. Congo Belge 37:865-890.

TINDALE, N. B. 1953. On some Australian *Cossidae*, including the moth of the Witjuti (Witchey) grub. Trans. R. Soc. South Aust. 76:56-65.

VANDERZANT, E. S. 1974. Development, significance and application of artificial diets for insects. Annu. Rev. Entomol. 19:139-160.

VILLAS-BOAS, O. and C. VILLA-BOAS. 1972. Xingú, os indios e seus mitos. Zahar, Rio de Janeiro. 246 pp.

WADDY, J. 1982. Biological classification from a Groote Eylandt aboriginal point of view. J. Ethnobiol. 2(1):63-77.

WAGNER, M. 1895. Das zeidelwessen und sein ordnung im Mittelalter und in der neuren Zeit. München. 235 pp.

WALLACE, A. R. 1852. On the insects used for food by the Indians of the Amazon. Trans. Entomol. Soc. London 2:241-244.

WEAVER, N. and E. WEAVER. 1981. Beekeeping with the stingless bee *Melipona beecheii* by the Yucatecan Maya. Bee World 62(1):7-19.

LITERATURE CITED (continued)

WHEELER, A. G., Jr. 1981. The tarnished plant bug: Cause of potato rot? J. Hist. Biol. 14(2):317-338.

WILBERT, J. 1979. Geography and telluric lore of the Orinoco Delta. J. Lat. Am. Lore 5(1):129-150.

______________. 1981. Warao cosmology and Yekuana roundhouse symbolism. J. Lat. Am. Lore 7(1): 37-72.

WILKEN, G. C. 1977. Interpreting forest and small-cale farm systems in Middle America. Agroecosystems 3: 291-302.

WYMAN, L. C. 1973. The Red Antway of the Navajo. Mus. Navajo Art. Santa Fe, New Mexico. 274 pp.

______________ and F. L. BAILEY. 1952. Native Navaho methods for the control of insect pests. Plateau J. Mus. North. Arizona 24(3):97-103.

______________. 1964. Navajo Indian Ethnoentomology. Univ. New Mexico Pub. Anthropol. No. 12., Albuquerque. 143 pp.

ZINSSER, H. 1935. Rats, Lice, and History. Blue Ribbons Books, New York. 259 pp.