Reprinted from Gerald G. Marten (1986), Traditional Agriculture in Southeast Asia: A Human Ecology Perspective, Westview Press (Boulder, Colorado).

9
Ethnoecology: An Approach to Understanding Traditional Agricultural Knowledge

J. Peter Brosius, George W. Lovelace, and Gerald G. Marten

The large and varied body of knowledge that farmers possess and employ is an important, yet often overlooked, element in the analysis of traditional agriculture. This information is extremely varied, ranging from detailed knowledge of specific plants to broader patterns of categorization that tell much about how a particular cultural group views the world it inhabits and how this helps to shape the group's interactions with the environment.

Broadly speaking, such indigenous knowledge falls into two categories. On the one hand, there is knowledge that is inherited from generation to generation and is generally shared by most of the members of the society. This cultural information is often passed on as folk wisdom in the context of folktales or is preserved and transmitted in the context of rituals and various religious ceremonies. The second category includes information gained through individual experience—empirical observations made by individual farmers during the course of agricultural activities. The two categories of indigenous knowledge are not mutually exclusive. Information collected by an individual may become knowledge that is shared by members of the group through time. The larger pattern of shared social knowledge also provides a contextual framework in which an individual's empirical observations can be interpreted and translated into knowledge. The existence of the common conceptual framework further allows farmers to communicate their observations and perceptions to other members of the local community with greater ease and with greater assurance that such communication will be understood.

Most anthropological studies of traditional knowledge have been conducted within the general framework of ethnoscience, which can be defined as "the study of systems of knowledge developed by a given culture to classify the objectives, activities, and events of its universe" (Hardesty 1977). A subset of ethnoscience, ethnoecology, refers to the study of how traditional groups organize and classify their knowledge of the environment and

environmental processes. Conklin (1954, 1955, 1957) and Frake (1961, 1962) suggested that ecologically oriented ethnographers should combine traditional techniques from cultural and biological ecology with others, principally derived from linguistics, that were deemed to be better suited to exploring native conceptions of the environment (Fowler 1977). An important aspect of ethnoecology, like that of the more inclusive ethnoscience, is a concern for describing and presenting knowledge from the cultural viewpoint. "An ethnographer cannot be . . . satisfied with a mere cataloguing of the components of a cultural ecosystem according to the categories of Western science. He must also describe the environment as the people themselves construe it according to the categories of their ethnoscience" (Frake 1962).

Ethnoecology is only one approach to understanding traditional knowledge and cannot be expected to explain everything we might desire about this topic. Nonetheless, ethnoecology has a substantial value for clarifying the ways in which traditional agriculturalists conceptualize the ecosystems on which they depend for a living. Its utility for understanding how traditional farmers interact with the environment will probably be greatest when combined with other approaches such as decision-making theory (Bartlett 1980).

BASIC ASSUMPTIONS OF ETHNOECOLOGY

Ethnoecology is based upon a number of interrelated assumptions. The most basic of these is that the environmental interactions of human beings, unlike those of other species, are greatly influenced by thought, knowledge, and language. In the context of and in response to environmental stimuli, these influencing factors interact to form a world view that strongly affects how humans act. "People do not directly respond to their environment but rather to the environment *as they conceive of it*: e.g., to animals and plants as conceptualized in *their* minds and labelled by *their* language" (Denton 1970). This point is encapsulated in Vayda and Rappaport's (1968) distinction between the "operational environment" (i.e., the sum total of all environmental features, comprehended or not) and the "cognized environment" (the environment as it is perceived and understood by a particular group of people). Similarly, Bates (1960) has drawn a distinction between the "perceptual environment" (containing elements perceived by the organism), the "effective environment" (containing elements, perceived or not, that affect the organism), and "total reality" (containing all elements, influential or not, that can be detected or inferred).

Another basic assumption of ethnoecology is that different groups of people, or "cultures," perceive and conceive of the world somewhat differently as a result of varying social, historical, cultural, and environmental conditions and experiences. This is not to say, however, that each culture or each society necessarily perceives the environment in an entirely unique manner. Indeed, one continuing question in much of the ethnoscientific literature has concerned the degree to which there are structural similarities that

underlie the different world views of separate groups as a result of either confronting similar problems in the process of adaptation or the shared status of being "human."

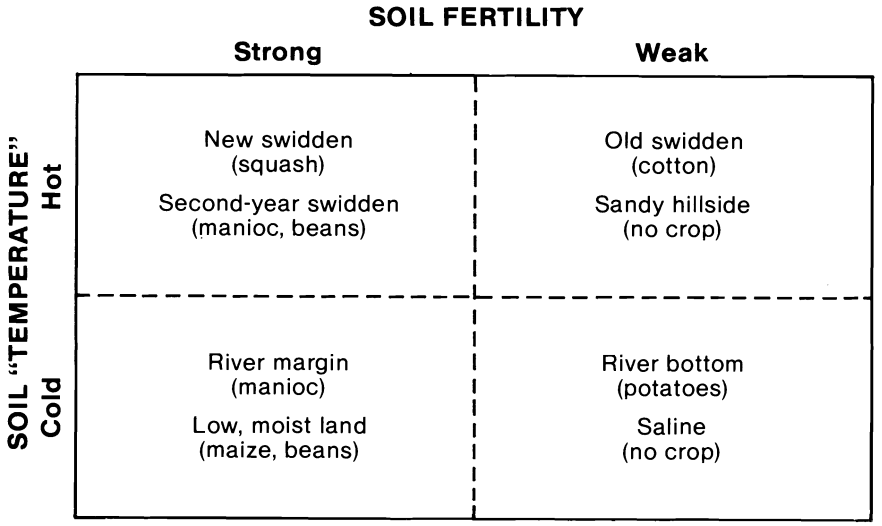
In attempting to understand both individual and shared perceptions and conceptions of environmental phenomena, emphasis can be placed on viewing the world from the actor's perspective, often referred to as the "emic approach." In contrast, an analytical framework that examines phenomena from a viewpoint other than that of the actor(s), such as the application of a framework derived from modern science, has been called an "etic approach." While proponents of each have argued for the ultimate correctness of their view, the two approaches can be considered complementary (Pelto 1970).

Reflecting their ethnoscience orientation, most ethnoecologists focus their attention upon the categories and labels of language, a primary form of human expression, in order to obtain information about the world view of the particular group of people. Typically, a researcher attempts to identify, through systematic verbal interviews, how people categorize and name different aspects of their worlds, what categories are employed, and what are the essential attributes of each category. By analyzing these varied elements, the researcher then attempts to identify those that have the greatest semantic and cognitive significance. The systematic study of semantic domains is often called "componential analysis" and produces taxonomies or keys in which terms and categories are arranged as a hierarchy of contrasts (Frake 1962, Goodenough 1956, Werner and Fenton 1973). Researchers have often sought to specify cultural "rules" as well. "After the taxonomies of the native terms have been constructed, the next step is the formulation of rules of what the native speakers themselves would regard as appropriate behavior toward the environmental phenomena placed by them in one or another category" (Vayda and Rappaport 1968).

Most studies have stopped at this point, leading some critics to label them more "ethnosystematics" or "ethnotaxonomies" than ethnoecology. Ideally, however, the research should proceed further to consider not only how the structured categories reflect an environmental world view, but also how this world view compares to one that might be derived from scientific ecology (keeping in mind that this scientific model is itself a product of the world view of Western science) and how the world view serves to structure and influence human behavior toward the environment. "Analyses of the shared cognitive aspects of human ecological systems must increasingly take into account the behavior which connects a people's ideas to the external environment in which they attempt to survive" (Johnson 1974).

Throughout the process of examination and analysis, there is the assumption that once the conceptual basis of indigenous peoples' interactions with their environments is understood, their actions and behaviors become intelligible and predictable. In other words, a connection is made between culture and behavior, between structure and event. "A description of cultural behavior is attained by a formulation of what one must know in order to

Figure 9.1. Land Classification of Swidden Farmers in Northeast Brazil[a]



Source: Adapted from Johnson 1974.

[a]Typical uses of each land category are shown in parentheses.

respond in a culturally appropriate manner in a given socio-ecological context" (Frake 1962). Although the prediction of appropriate and adaptive behavior is a primary goal of ethnoecology, the actual achievement of articulation between cognition and behavior is a difficult task and few analyses have been able to demonstrate more than particular systemic relationships.

EXAMPLES FROM TRADITIONAL AGRICULTURAL SOCIETIES

Sharecroppers in Brazil

One example of articulating a cognized model with environmental events and behavior is provided by Johnson's (1974) study of ethnoecology and planting practices by sharecroppers in northeast Brazil. The study compares two sets of data on swidden agricultural activities by these farmers. The first set consists of a cognitive model of land categories, their attributes, and "rules stating which crops like which lands best." There were eight relatively stable and mutually contrasting land categories (Figure 9.1), which the sharecroppers tended to identify in terms of two sets of attributes, one set reflecting soil fertility ("strong" vs. "weak") and the other referring to soil moisture ("hot," meaning dry, vs. "cold," meaning wet), which reflects soil drainage conditions.

The sharecroppers verbally associated individual crop types with particular combinations of land attributes. In the case of squash, for instance, the most "liked" lands were those that were "strong" and "hot." There were two varieties of manioc, one preferring lands that were "strong" and "cold" and the other preferring "hot" soils. The association of crops with land categories was codified by rules such as the following:

1. One need not bother planting crops on sandy hillsides or saline soils.
2. It is "almost" worthless to plant on an old swidden field.
3. River bottoms will only produce potatoes.

Johnson then proceeded to compare the cognitive model to actual planting behavior by a number of the sharecroppers. In general, there was a positive correlation, although some deviations from the expected pattern were noted. Some of these exceptions reflected purely idiosyncratic behavior, while others appeared to indicate the operation of "rules" and principles beyond the "land category" paradigm. For example, inclusion of the "principle of crop interference," in which certain crops are considered not to grow well with other crops, might generate a more complex paradigm that would "increase the predictive power of the cognitive model" (Johnson 1974).

San Blas Cuna (Panama)

The San Blas Cuna, a population of agriculturalists and fishermen who occupy the northeast coast of Panama, provide an example of how the socioeconomic context can shape the way people categorize their agriculture. The Cuna agricultural system consists of a combination of subsistence-oriented swidden agriculture and more permanent tree crop cultivation (Howe and Sherzer 1975). The two most important crops, bananas and coconuts, are suitable for harvesting on a year-round basis, with some fruit generally available at any given time. Landholding practices of the San Blas Cuna are such that each agriculturalist will typically own a number of different plots of land scattered over a wide area. Unable to be all places at all times, San Blas Cuna farmers find that theft is a recurrent problem. An additional factor is a Cuna cultural obligation to be generous, with considerable emphasis put on generosity with raw agricultural products. The value on generosity raises, as Howe and Sherzer (1975) note, some interesting questions concerning its relationship to the problem of theft. "One of the most frequently voiced criticisms of thieves is that they could get what they wanted without having to steal it."

In this socioeconomic context, the San Blas Cuna have come to classify crops and wild forest products according to who besides the owners should have access to them and according to the kind of access that is involved. For example, access to bananas is limited solely to the owner, even if they are rotting on the ground, whereas access to coconuts (a staple), while also restricted, is still possible provided that one has received the owner's

permission, which is usually given. Crop plants and fruits may be taken without asking or only after telling the owner.

As in the case of the Brazilian sharecroppers described in the preceding section, there are some discrepancies between the San Blas Cuna's cognitive ideal and their actual observed behavior. "Though informants generally presented the rules as if there were only one correct version, they sometimes noted that what people actually did and what they actually expected others to do was less demanding than the strictest form of the rule" (Howe and Sherzer 1975). While this might lead one to conclude that the rules of access are "merely epiphenomenal," it was nevertheless clear that they did influence the actions of many people within the population.

Ifugao (the Philippines)

Some insights into the kinds of folk conceptualizations that underlie resource allocation and other management decisions in a complex and dynamic traditional agroecosystem are provided by the Ifugao, who live in a mountainous area of northeastern Luzon. They "have long been known for their astonishing feats of engineering in the construction and maintenance of extensive rice terraces, the visually most impressive aspect of the intricately patterned landscape" (Conklin 1967). The elements of the Ifugao agroecosystem are many and varied, including:

> the availability of water for irrigation and soil transport; suitable earth or stone for construction and repair of embankments; a variety of vegetational habitats as sources of fuel, fencing, and other construction materials; a large number of protected and cultivated plant types; . . . sufficient labor to keep up the annual round of repairs, cultivation tasks, and associated rituals; and—most important—the knowledge of how these and many other factors are interrelated and how they may be profitably utilized (Conklin 1967).

The complexity of both the local terrain and the indigenous agricultural system is reflected in Ifugao folk classification, which allows inhabitants to distinguish hundreds of terrain variations involving natural attributes as well as those that result from agronomic activity. Indigenous concepts of land form range from broad general categories, such as "mountainous slopeland" *(bilud)*, to highly specific categories, such as "underground drainage conduits" *(qanul)*. At an intermediate level of this essentially hierarchical range of terrain forms, Conklin distinguishes eight basic categories: grassland, forest, caneland, woodlot, swidden, house terrace, drained field, and pond field. Each of these culturally significant land categories can be distinctively defined in the Ifugao context as particular combinations of attributes related to slope, soil, vegetation, and the extent of human management. The eight basic land concepts not only reflect contemporary patterns of land use, but also what is for the Ifugao an "ideal" sequence of landscape modification and transformation in relationship to occupying the environment. The sequence begins with natural forest and progresses through various stages toward an intensely utilized agroecosystem that is dominated by paddy fields, house terraces, and woodlots.

Huastec Indians (Mexico)

A final example is the perception and management of botanical resources among the Huastec Indians, agriculturalists descended from the prehistoric Maya and inhabiting the coastal area of northeastern Mexico. Huastec subsistence is characterized by a combination of subsistence agriculture, cash cropping, and collecting, supplemented by products purchased with money earned through wage labor (Alcorn 1981). Staples such as maize and manioc are produced primarily in swidden *milpas* (cornfields) and gardens, a pattern that has resulted over the centuries in close interaction between the region's forest ecosystem and the Huastec Indians.

The Huastec are of interest for several reasons. First, Huastec perception and classification of botanical resources are considerably different than those of a Western-trained botanist. Terms and concepts that many botanists might see as relatively clear cut, such as "wild," "domesticate," and "weed," become blurred in the Huastec context. For example, the same plant species may or may not have the status of a "weed," depending upon the particular situation or time in which it occurs or the particular perspective and knowledge of the observer.

As the perceived resource status of individual plants and vegetation zones changes in relationship to such factors, so do the responses and plant management practices of the Huastec. Plant management usually involves two types of plant manipulation: manipulation of individual plants and manipulation of the vegetation en masse. These are related to the fact that the same plant can be seen either as part of the overall vegetation or as a specific plant against the backdrop of the larger vegetative pattern. "This subjective classification can be seen most graphically when, machete in hand, the human momentarily decides whether to slash back the plant, or to spare it, slashing the vegetation around it" (Alcorn 1981).

Because it affects the composition, spatial distribution, numerical representation, and even in some cases the genetic structure of many plant species, such manipulation injects an important human element into the local pattern of vegetation, creating "anthropogenic vegetation zones" that overlap the natural microenvironmental variation. These zones are spatially dynamic, moving about through time in connection with continuing patterns of Huastec plant manipulation. Such vegetation modification has likely been occurring for centuries and has had a significant and lasting impact on the region's rainforest. The same kind of management of natural and semi-domesticated vegetation is also common among forest-dwelling farmers in Southeast Asia, as Rambo (1982) has documented for aboriginal forest people in Malaysia.

TRADITIONAL CONCEPTUALIZATIONS OF THE ENVIRONMENT

The studies that have been described here indicate the sort of topics that ethnoecologists have considered. Although varying in subject and scope, the studies share a concern for examining how a society's or group's world

view, as suggested by its systems of classification, reflects and affects its interactions with the environment. It would be premature, however, to conclude that ethnoecological research has progressed much beyond demonstrating that world view and classification systems, behavior, and environment are interconnected. In fact, there remain many important questions that deserve attention.

Ecological Relationships and Processes

Much ethnoecological research has concerned the labeling and classification of relatively discrete entities and categories that can be distinguished from one another with a knowledge of appropriate attributes. It was determined, for example, that the Hanunoo recognize and distinguish 1,600 different plant types (Conklin 1954, 1955). An emphasis on entities tends to overlook the relationships and processes that occur among ecosystem components, i.e., those attributes that make an ecosystem a "system."

In fact, traditional agriculturalists possess a wealth of environmental and ecological knowledge that goes beyond the simple naming and classifying of discrete objects. For example, Negrito swiddeners in western Luzon, the Philippines, not only recognize more than eighty kinds of birds but also have considerable knowledge of bird-environmental interactions, including detailed awareness of the habitats and foods of each species, their seasonal abundance and distribution, and what the presence or absence of particular species of birds indicates about the state of a given area. The Karam, a horticultural tribe in highland New Guinea, have considerable knowledge concerning "the integration of the plant and animal communities—of the topographic, soil and climatic conditions required by wild as well as cultivated plants, of the kinds of plants and their parts which provide food or refuge for different kinds of animals, of which animals prey upon which other animals, of the role of birds and mammals in the propagation and dispersal of certain plants" (Bulmer 1974).

Traditional agriculturalists do not live in static worlds. They are surrounded by change, especially cyclical change, and are well aware of it and capable of conceptualizing it. The recognition of seasonal rhythms and their critical relationship to the organization of agricultural activities is manifested in agricultural calendars. For example, the traditional *pranatamangsa* calendar of Java reflects the seasonal monsoon cycle of the area and has served traditional farmers in Java for centuries as a practical guide for their agricultural activities. "The Javanese peasant organizes his agricultural activities throughout the year in relation to . . . the calendar's . . . seasons, and he believes that if he departs from traditional seasonal patterns, his work will fail either totally or partially" (Daldjoeni 1984). The seasons are of unequal length and bear names that reflect their impact on human welfare, due in large measure to the abundance or scarcity of food in the course of the agricultural cycle—"clear sky," "scarcity," "despair," "full hope," "river flood," and "disease" seasons. The months are also of unequal length, varying from twenty-three to forty-three days, and bear names such as "cracked soil," "a feeling of holiness" (because all of nature is green), "poison blowing the wind" (a time of floods and disease), and "a jewel (i.e., dewdrop) falling from its setting."

Tiruray shifting cultivators in the Philippines also have seasons of unequal length. Three key events in their agricultural cycle are clearing a field in the forest, burning it, and planting their rice in it. Each of these must fall within a prescribed season that is defined according to which constellation is at the zenith immediately after sunset or before dawn (Schlegel 1967). The constellations are named after mythical personages whom the Tiruray believe to have been placed in the sky to help them pursue their agriculture. Exactly when in the specified season these activities take place is a matter of personal judgment, but the timing is crucial. Trees must be felled enough in advance to allow time for the clearing process, but not too much in advance or the field will become filled with young weeds (because of the increase in sunlight at ground level after felling trees) that are difficult to remove by burning. Burning must be done after a long, dry period and when winds are strong enough to carry the fire throughout the field. After burning, if the rice seed is sown too much in advance of the rains, the seeds will deteriorate and may also fall prey to ants. If the rice is sown too late, the soil is too wet for dibbling, and weeds have the opportunity for a head start on the rice.

In Northeast Thailand, an area of unpredictable rainfall and frequently dry conditions, farmers often rely upon a variety of faunal and floral clues to help them predict patterns of precipitation. For example, some farmers observe the fruit-bearing patterns of perennial crops such as tamarind, custard apple, kapok, and mango trees to predict how soon the rainy season will start and how much rain there will be (Suphanchaimat and Grisnaputi 1985). Some farmers also rely upon the coloration of monitor lizards to predict whether there will be a drought at the end of the rainy season; others observe how high above the ground specific insects lay their eggs in the grass—higher above the ground reflecting the prospect of more rain because height protects the eggs from flooding.

Change is often an important element in the terminology that farmers use to describe ecological conditions. Many Southeast Asian shifting cultivators speak of the improvement in soil fertility during the fallow period as an increase in "fatness" and clearly recognize that a fallow is necessary to replace the "grease" depleted during a cropping period. Recognition of such concepts presents a wide range of research questions relevant to traditional understanding of changes in soil fertility. Where, in the traditional farmers' conception, does "grease" come from? How is it recognized? Why is it depleted? How does the process of increasing "fatness" proceed?

One way to recognize traditional knowledge on ecological processes is to shift attention from nouns—the names and labels that are the basis for taxonomies—to verbs and adjectives. Verbs, by their very nature, frequently suggest process and its linguistic recognition. Verbs also are important in human conceptualization of adaptation. "Every language has a large folk

terminology of adaptative strategies in the generalized sense: coping, changing, rectifying, correcting, curing, ameliorating, modifying, manipulating . . . all are English words referring to ways of altering circumstances" (Bennett 1976). Undoubtedly, a large lexicon of more specifically ecological referents exists in any given language, and an understanding of such terms opens the way for understanding the concepts and processes that underlie them.

Individual and Intra-Group Variation in Agricultural Knowledge

Although we tend to think of traditional knowledge as equally shared by all members of a group, so that everyone's knowledge is the same, each person's knowledge is in fact somewhat different. This is because knowledge is for most people a combination and synthesis of, first, information received from others and, second, personal experience. Each influences and shapes the other.

While the role of shared cultural knowledge in providing an interpretative context for personal observations is well recognized, much less is known about the role of experience, both as a source of new information and as a referrent and strong reinforcement for received information. Yet, individual experience is an extremely important element in the overall process, as Bulmer (1974) observed for the Karam of New Guinea: "In the complex synthesis of information received from others and personal experience which constitutes an individual's store of knowledge, I am struck most forcibly by the very important role of personal experience. Time and again my informants refer to personal observation, and neither to the authority of tradition nor the testimony of others, in justifying the categories they use and the interpretations of biological processes they offer."

The role of the individual is also significant with regard to experimentation in traditional agriculture. The use of the word "traditional" may convey an impression of strategies, tactics, and information that are unchanging because they have proven adaptive through countless generations and in countless situations. In fact, the cultivators in many traditional agricultural societies are not at all adverse to experimentation: "Experimentation is probably as natural as conformity in traditional communities" (Johnson 1972).

Just as knowledge varies among individuals, it tends to vary with respect to particular groups of people within the larger social unit. Such variation often reflects differences in age, sex, class, and occupation that in many sociocultural and economic contexts can either restrict or increase exposure and access to certain kinds of information and experiences. Among the Ifugao of northern Luzon, for example, women who have responsibility for selecting rice seed are usually more knowledgeable with respect to different varieties of rice and their distinguishing characteristics than are men (H. Conklin, pers. comm.).

Potential variation in traditional knowledge at the levels of the individuals and subgroups within societies raises many topical as well as methodological

questions. For example, how exactly is an individual's knowledge related to the knowledge of the society? Assuming that new knowledge is ultimately created by individuals, how is social knowledge created or acquired and what factors affect its creation or acquisition? In terms of methodological questions, on the other hand, perhaps the most crucial issue is whether the existence of individual variation in knowledge makes it virtually impossible to isolate knowledge that is truly shared, especially where interviewing of individuals is the primary method of gathering information on the traditional pattern of knowledge.

ACKNOWLEDGMENTS

This chapter was developed from a manuscript on ethnoecology written by J. Peter Brosius in 1983.

REFERENCES

Alcorn, J.B. 1981. Huastec noncrop resource management: Implications for prehistoric rain forest management. *Human Ecology* 9:395–415.

Barlett, P.F., ed. 1980. *Agricultural Decision Making*. New York, N.Y.: Academic Press.

Bates, M. 1960. *The Forest and the Sea: A Look at the Economy of Nature and the Ecology of Man*. New York, N.Y.: Random House.

Bennett, J.W. 1976. *The Ecological Transition: Cultural Anthropology and Human Adaptation*. London: Pergamon.

Bulmer, R.N.H. 1974. Folk biology in the New Guinea highlands. *Social Sciences Information* 13:9–28.

Conklin, H.C. 1954. An ethnoecological approach to shifting agriculture. *New York Academy of Sciences, Transactions* 17:133–42.

Conklin, H.C. 1955. Hanunoo color categories. *Southwestern Journal of Anthropology* 11:339–44.

Conklin, H.C. 1957. *Hanunoo Agriculture: A Report on an Integral System of Shifting Cultivation in the Philippines*. Rome: UN/FAO.

Conklin, H.C. 1967. Some aspects of ethnographic research in Ifugao. *New York Academy of Sciences, Transactions*, Series 2, 30:99–121.

Daldjoeni, N. 1984. *Pranatamangsa*, the Javanese agricultural calendar—its bioclimatogical and sociocultural function in developing rural life. *The Environmentalist* 4(Supplement No. 7):15–18.

Denton, R.K. 1970. An appeal to members of the society from an anthropologist. *Malayan Nature* 23:121–22.

Fowler, C.S. 1977. Ethnoecology. In *Ecological Anthropology*, ed. D.L. Hardesty, pp. 215–43. New York, N.Y.: John Wiley and Sons.

Frake, C.O. 1961. The diagnosis of disease among the Subanum of Mindanao. *American Anthropologist* 63:113–32.

Frake, C.O. 1962. Cultural ecology and ethnography. *American Anthropologist* 64:53–59.

Goodenough, W. 1956. Componential analysis and the study of meaning. *Language* 32:195–216.

Hardesty, D.L. 1977. *Ecological Anthropology.* New York, N.Y.: John Wiley and Sons.

Howe, J., and J. Sherzer 1975. Take and tell: A practical classification from the San Blas Cuna. *American Ethnologist* 2:435–60.

Johnson, A.W. 1972. Individuality and experimentation in traditional agriculture. *Human Ecology* 1:149–59.

Johnson, A.W. 1974. Ethnoecology and planting practices in a swidden agricultural system. *American Ethnologist* 1:87–101.

Pelto, P.J. 1970. *Anthropological Research: The Structure of Inquiry.* New York, N.Y.: Harper and Row.

Rambo, A.T. 1982. *Orang asli* adaptive strategies: Implications for Malaysian natural resource development planning. In *Too Rapid Rural Development: Perceptions and Perspectives from Southeast Asia,* eds. C. MacAndrews and L.S. Chia, pp. 251–99. Athens, Ohio: Ohio University Press.

Schlegel, S.A. 1967. Tiruray Constellations: The agricultural astronomy of a Philippine hill people. *Philippine Journal of Science* 96:319–31.

Suphanchaimat, N., and W. Grisnaputi. 1985. Traditional knowledge on rainfall prediction of the Khon Kaen rice farmers in Thailand. *Proceedings of the EAPI-SUAN Symposium on Research on Impact of Development on Human Activity Systems in Southeast Asia,* August 1983, ed. O. Soemarwoto. Institute of Ecology, Padjadjaran University, Bandung, Indonesia.

Vayda, A.P., and R. Rappaport. 1968. Ecology: Cultural and non-cultural. In *Introduction to Cultural Anthropology,* ed. J. Clifton, pp. 476–97. Boston: Houghton-Mifflin.

Werner, O., and J. Fenton. 1973. Method and theory in ethnoscience and ethnoepistemology. In *A Handbook of Method in Cultural Anthropology,* ed. R. Naroll and R. Cohen, pp. 537–78. New York, N.Y.: Columbia University Press.