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## NUTRITIONAL ECOLOGY: A NEW PERSPECTIVE<sup>1</sup>

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Populations have differential but potentially specifiable nutritional requirements. In various ecosystems, essential substances such as salt, water and certain vitamins and minerals are differentially represented, and populations exhibit variable efficiency in extracting these substances from the environment. Those groups that exist with only limited outside contact have managed to maintain a fairly balanced diet by taking advantage of a variety of natural food resources, including insects, rodents, and the internal organs of game which are rich in vitamin B<sub>12</sub>. Man's apparent success in extracting essential nutrients<sup>2</sup> from a particular ecosystem lies not only in the differential patterns of exploitation, but also in his adaptive capacity and represents a long-term process of experimentation, the immediate effects of which are not necessarily cognized. However, nutritional deficiencies<sup>3</sup> may occur in response to physiological disturbances resulting from inadequate digestion, absorption or utilization of nutrients consumed; or, these deficiencies may indicate either environmental inadequacies or exploitative inefficiencies. In order to offset these deficiencies, socio-cultural

instrumentalities, such as trade relations, food taboos, certain ritual observances and culinary practices, may come into play as populations devise specific strategies which are employed as ecological problem-solving devices.

Traditionally, ethnographers viewed subsistence activities, trade, food taboos and rituals to be described as separate entities and in some instances placed in predetermined categories of social behavior. Nutritional ecology is an attempt to give an ecological as well as a nutritional interpretation to cultural data. Nutritional requirements of populations as well as the actual intake vary with environmental and cultural conditions. Both annual and seasonal fluctuations in the abundance and variety of food resources often lead to trade relations as described in the reinterpretation of the Northwest Coast Potlatch (Suttles 1968; Piddocke 1965). Such ritual practices as the pig feast in Melanesia show correlations between the increased need for protein intake as a result of negative nitrogen balance and stress (Vayda n.d.). A nutritional approach ideally extends the interpretation one step further, with a qualitative as well as a quantitative analysis of the essential nutrients provided. Once the actual food consumption is determined, a caloric value is

established with an analysis of the protein, carbohydrate and fat content. Vitamin and mineral composition is also established. Caloric cost evaluation--that is, specification of energy expenditure versus caloric yield--is equally important in a nutritional approach to subsistence activities.

Optimum utilization of protein is necessary for growth and development and is dependent on the presence of the eight essential amino acids in proper ratio<sup>4</sup>. Maintenance equilibrium can be achieved on approximately 20-30 grams of protein per day, with greater amounts needed for pregnant and lactating women (Harrison, et al. 1964). With some variation owing to climatic conditions, quality protein requirements are determined on the basis of 1 gram per kilogram of body weight (Garn and Block 1970). In warmer climates, caloric needs are lower (at least partly because caloric expenditure for body temperature maintenance is lessened), but protein requirements may be higher by as much as 5-10 grams per day (Mitchell and Edman 1951:94). Salt and water needs are also higher in warm climates, although fully adapted or acclimated peoples seem to have special physiological mechanisms to conserve these nutrients; in addition, increased sweat and fecal losses call for increased intake of iron, and possibly

of calcium. In cold climates a higher ingestion of fat is needed for insulation and fuel storage. By way of illustration, fat intake among the Eskimo is 162 grams (1,458 calories) per person per day, as opposed to 63 grams (567 calories) daily in the population of tropical Barbados (Harrison 1964). There is also some evidence that fat requirements are high in arid areas as well (Newman 1962).

Physiological reactions to vitamin and mineral deficiencies have been described in the literature in detail; however, little attention has been given to the effects of nutritional deficiencies on cultural behavior. An example of a nutritional deficiency involving cultural adaptation is the Eskimo's response to Piblokto (Eskimo madness). This condition is the result of a breakdown of calcium homeostasis caused by low dietary intake of calcium coupled with inadequate sunlight for vitamin D synthesis. (Vitamin D, along with phosphorus, is necessary for calcium absorption.) Wallace and Ackerman (1960) suggested that Piblokto was the result of hypocalcemia brought about by the inability to adapt physiologically to low calcium intake. Piblokto occurs during the winter and early spring, when the Eskimo are living in large groups and when there is little sunlight. It begins with a period of social withdrawal and culminates in

"running amok," spasms, collapse and finally total recovery. Running amok is probably preceded by anxiety and hyperventilation, which result in a partial depletion of calcium ions in the system. Shamanistic practices in times of stress resemble Piblokto behavior; in other words, the culture not only accomodates but also capitalizes on this response. We interpret this as an example of the manner in which cultural instrumentalities come into play in the absence of or in advance of biological adaptation to the exigencies of the habitat (see Katz and Foulkes 1970).

The nutritional content of foods is often enhanced by the specific culinary techniques employed. The Mesoamerican practice of soaking maize in lime increases the calcium content twenty times. In parts of Africa, baobab leaves are dried in the shade rather than in the sun, resulting in greater vitamin retention. In parts of Southeast and Insular Asia, the nutritive value of soybeans is increased by germination and fermentation. Culinary practices in the Near East provide another example; here, in the absence of techniques for its preservation in the raw state, milk is allowed to curdle and then is dried and mixed with wheat (Harrison, et al. 1964).

Dietary habits are conditioned by the availability of food resources, certain sociocultural instrumentalities (e.g., food taboos), and extrasocietal

influences. Food taboos generally take one of the following forms: 1) a general prohibition on the slaughter or consumption of specific animals; 2) the restriction of certain foods to particular segments of the population; and 3) temporary, situational restrictions (e.g., before or during war, during menstruation or after parturition). Taboos of the latter two types often have the effect of channelling food to those members of the population undergoing a temporary or chronic nutritional deficiency. Vayda and Lowman-Vayda (1970:1312) provide an example from the Maring of New Guinea. They state that inherited food taboos in the form of proscriptions on the men's consumption of hunted game have "...the beneficial effect of making more of the scarce animal protein available to categories of people who especially need it: women, who are likely to be either lactating or pregnant, and growing children."

Ritual practices frequently constitute devices to offset environmental inadequacies. For instance, the Karimojong of Uganda maintain a complex system of food production including animal husbandry, agriculture and gathering. Yet, the primary source of food is the blood and milk of cattle. During the dry season, milk supply and agricultural productivity are both low. At this time, rituals are performed that

include prayers for better times and the sacrificial slaughter (and consumption) of cattle, that is, ritual activity permits utilization of a resource normally held in reserve.

When societies are displaced or disrupted by external forces, the wisdom developed through centuries of trial and error may cease to be relevant. For example, the Zulu of South Africa were forced to change from their traditional diet to one that gives a higher caloric yield, but which also results in an unbalanced diet. White settlers moving into the area encouraged the cultivation of maize instead of millet. Maize gives a higher yield and requires less work (Dubos 1965:68-69). On the other hand, millet is higher in methionine and tryptophane than maize (Richard Bozian, personal communication). A second factor contributing to the unbalanced diet is the movement of settlers onto land formerly used for hunting and gathering. The game and berries so essential in the original diet are no longer available.

With the trend toward a market economy, traditional agriculture is being commercialized as subsistence crops are replaced by such cash crops as cotton, groundnuts, coffee, etc. The reaction to the introduction of generalized money appears to be similar cross-culturally. This money is used initially

to procure trinkets and prestige items introduced by Westerners. Only later is the money used to purchase items for consumption in an attempt to supplement the diet and perhaps offset the malnutrition which develops from an imbalance of nutrients.

Agricultural development has been approached primarily from an economic perspective, with an emphasis on yield in order to cope with the problems of undernutrition in the world today. The introduction of such high yield grains as IR-8 (miracle rice) may alleviate the problem of inadequate caloric intake. Unfortunately, subsistence based primarily on cereals may lead to malnutrition and increased susceptibility to disease. For instance, wheat flour is low in zinc, a deficiency of which leads to beri-beri and slow wound healing. In areas where cereals constitute the main diet, Shroeder (1970) indicates that phosphate fertilizers aggravate zinc deficiency and suggests the use of a zinc supplement. The process of refining cereals has a detrimental effect in that 80-90% of the mineral elements of the cereal are deleted (Hemphill 1967).

Phillips (1959:383) suggests that the one and only foundation to agricultural development is an ecological one--constituted by knowledge of the climate, vegetational and soil features of a specific

locality. Nutritional ecology, as we are using the term, combines this approach with a survey of all available subsistence resources in the ecosystem. In the remainder of this paper, we suggest some guidelines for the field study of nutritional ecology.

First, the anthropologist must have at his disposal a complete ecological study of the ecosystem; multidisciplinary team research is crucial.

Second, the anthropologist must determine the way in which the ecosystem is cognized and exploited. All analysis on this level must be conducted in terms of local cognitive categories ("folk taxonomies"). Steward's (1955) and Netting's (1965, 1968) discussions of "effective environments" are pertinent here.

Third, the actual nutritional requirements must be determined for the society being studied. Most available nutritional studies reflect only the requirements of members of Western societies. These standards cannot be applied cross-culturally, because nutritional needs vary in accordance with such factors as climate, altitude, and probably, genetic constitution<sup>5</sup>. In addition, activity rates affect nutritional needs. In this regard, the division of labor (whether according to sex or along any other dimensions) must be taken into account (see Rappaport 1967), both in the study of particular societies and in

making cross-cultural comparisons.

Fourth, it is necessary to determine the exploitation of seasonally available subsistence resources as well as seasonal and annual variations in the distribution and abundance of food resources as affected by climatic fluctuations.

Fifth, the study must specify how the distribution of subsistence resources is undertaken in the society in terms of food restrictions, ceremonial cycles, and seasonal demographic patterns.

Sixth, the study of nutritional ecology as we have discussed it will require a change not only in the conceptual, but also in the organizational structure of field research and data analysis. The research problems of modern anthropology are beyond the capacities of the one-man scholar.

## NOTES

1. An earlier version of this paper was prepared for a class in Cultural Ecology taught by Prof. Kent D. Vickery. We thank Prof. Vickery and Profs. Barry Issac and Ivan Brady for their criticisms of subsequent drafts.
2. Essential nutrients are those elements necessary for life maintenance. Over fifty have been identified chemically including 14 trace elements, 8 amino acids, salt, water, etc.
3. Nutritional deficiencies constitute a lack or inadequate supply of essential nutrients.
4. Essential amino acids include isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophane and valine.
5. Techniques have not yet been developed for measuring cross-cultural differences in requirements of vitamins, minerals, amino acids, and certain other essential nutrients.

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