

# The Utilitarian Factor in Folk Biological Classification

EUGENE HUNN

University of Washington

*This paper argues that ethnoscientists interested in folk biological classification have paid insufficient attention to the practical significance of such systems of cultural knowledge in their pursuit of general logical and/or perceptual principles governing the form and content of folk biological taxonomies. It is suggested that ethnoscientists adopt an adaptationist stance in recognition of the fact that cultural knowledge is used to guide behavior. The implications of such a shift in emphasis on folk biological classification theory are assessed. Present theory is rent by a fundamental contradiction between a formal taxonomic hierarchy model and one based on the contrast between a general purpose, biologically natural taxonomic core and special purpose, biologically artificial peripheral taxa. The natural core model is advocated as both superior in explanatory power and explicit in recognizing the purposes of classification. C. Brown's life-form universals are criticized for confounding the fundamental contrast between general purpose and special purpose life-form taxa. In conclusion, there is a discussion of the difficulty of developing a valid measure of the practical significance of a taxon, suggesting as a first step toward that goal the systematic description of each taxon's unique "activity signature." Such activity signatures are then to be evaluated in the context of a culture's system of "routine action plans" which link cultural knowledge and adaptive behavior. The desired result is a new ethnoecology integrating ethnoscientific and ecological theory. [ethnoscience, taxonomy, folk biology]*

## INTRODUCTION

LÉVI-STRAUSS OPENS *The Savage Mind* (1966) by asserting that "the universe is an object of thought at least as much as it is a means of satisfying needs" (p. 3). He reflects on Handy and Pukui's characterization of native Hawaiian ethnobiology. They had noted that "every botanical, zoological or inorganic form that is known to have been named . . . was *some thing* used . . . in some way" (Handy and Pukui 1953:127). Lévi-Strauss remarks that to characterize something as of no *use* is quite apart from it being of no *interest*, as "'use' concerns practical, and 'interest' theoretical, matters" (p. 2). Ethnoscience investigations of folk biological classification have been favorably disposed to this point of view and have thus analyzed their subject matter as reflecting an intellectual or cognitive process of comprehending the world, a process motivated by "interest" first of all. This approach has been fruitful. It has generated theoretical models of perceptual, cognitive, and linguistic processes that underlie "natural categorization" (e.g., Hunn 1976; Kay 1971, 1975; Rosch 1978). However, the fact that cultural knowledge of the

---

EUGENE HUNN is Associate Professor, Department of Anthropology, University of Washington, Seattle, WA 98195.

Copyright © 1982 by the American Anthropological Association  
0002-7294/82/040830-18\$2.30/1

natural world might also be of use practically has been treated as beside the point, almost as an embarrassment. Berlin, in a theoretical stock-taking addressed to an audience of biosystematists (1973), felt called upon to stress that "less than half of the named folk generic classes [i.e., basic core folk taxa] of plants in the folk botany of the Tzeltal . . . can be shown to have any cultural significance whatsoever" (p. 260).

We have been misled by Lévi-Strauss on this point. A careful examination of Berlin's own data discloses some explicit or likely practical relevance for nearly all of the Tzeltal folk botanical categories he has labeled "culturally insignificant" (Boster and McDaniel 1979). Some are poisonous, others invasive weeds, other inedible "twins" closely resembling edible forms, others useful "just" as firewood, and so forth (Berlin, Breedlove, and Raven 1974: 277, 278, 291, 499, 500-501, 507-508, 512-513). Yet they are classed as "culturally insignificant."

These same Tzeltal Indians exhibit strong preferences for those parts of their zoological universe they consider worth bringing classificatory order to. For example, adult Lepidoptera (butterflies and moths)—the subject matter of a classificatory obsession of certain civilized folk—are of very little interest to the Tzeltal. Yet their larvae (caterpillars, cutworms, etc.) are carefully sorted into 16 terminal folk taxa in Tzeltal (Hunn 1977:280-285, 301-306). Some lepidopterous larvae are edible, others attack crops, and others acquire painful defensive ornamentation. The adults lack these characteristics. As a general rule, larval Lepidoptera are specialized for feeding, adults for mating, hence their contrasting cultural impact on the Tzeltal. There is, of course, ample morphological diversity visible to the human eye among both adult and larval Lepidoptera upon which to base a classificatory ordering. Yet for swidden farmers the larvae are noteworthy, the adults are not. The classificatory detail applied is clearly in large part a function of practically motivated interests in the Tzeltal case, but of a compulsion for intellectual order on the part of the civilized butterfly fancier.

We have unduly stressed the disinterested intellectualism of our informants, and as a consequence have taken for granted their practical wisdom. Pragmatism is no sin. Folk science is for the most part applied science, rarely truly theoretical (e.g., Jones and Konner 1976). To properly appreciate the achievements of folk science, we need to investigate its practical significance as assiduously as we have its formal order.

The emphasis placed on "classification for its own sake" by ethnoscientists and other "idealist" anthropologists is in reaction to the materialist argument that, given an energy investment in knowledge, knowledge must be "useful," that is, adaptive. This argument is often both crude and trivial. It is crude when "adaptive" is measured in energetic or monetary terms. Thus, "useful" is reduced to a calorie count or an economic cost-benefit analysis. Lévi-Strauss interprets the term "use" as opposed to "interest" in this way. Such analyses assume a unidimensionality of motivation which leaves much of human action unexplained. The argument is trivial when the usefulness of an item of cultural knowledge is deduced from the fact of its existence, tautologically, then "explained" by analytic tour de force. For example, the utility of avoiding a species is first assumed, then explained by an alleged adaptive advantage—measured calorically—gained by avoiding the tabooed item in favor of more efficiently exploited prey (Ross 1978).

Such utilitarian/adaptationist explanations are rightly criticized for oversimplification (Hays 1982), for assuming that if culture is adaptive, any arbitrarily isolated segment of culture will also be adaptive (see Lewontin 1978 for a parallel critique of adaptationist arguments in evolutionary biology). Such explanations ignore the complexity of organization of systems of cultural knowledge that has been the focus of analyses of cultural systems by opponents of materialist explanation. However, I believe it is wrong to reject the adaptationist premise because of the methodological and conceptual short-

comings of its leading proponents. The premise that cultural knowledge is adaptive is as axiomatic as the assertion that culture is a complex and "logical" whole.

What is required is a synthesis that combines the cognitive psychological insight and methodological sophistication of ethnoscience with the explanatory power of modern evolutionary theory. Though no such synthesis now exists, my purpose here is to document the need for such a synthesis and to suggest some initial steps in that direction. For example, I will evaluate the implications of an adaptationist theory of culture for my own ethnoscientific research specialty, folk biological classification. The central issue is whether the study of folk biological classification can be profitably pursued in the future outside the context of its use, as has been the case in the past for all intents and purposes. I will argue that the folk biological domains of knowledge cannot be adequately understood in such a functional vacuum. The need to take account of the practical relevance of folk biological concepts is demonstrated by showing the weaknesses of current analyses of folk biological classifications, analyses that explicitly exclude functionally motivated categories from their purview. In conclusion, I will argue that ethnoscience is well suited to the task of creating this synthesis, of explaining the practical relevance of complex cultural systems.

#### FOLK BIOLOGICAL CLASSIFICATION AS A GENERAL PURPOSE SYSTEM

Folk biological classification has been approached as if information about plants and animals were stored in people's heads in taxonomically organized domains (Berlin, Breedlove, and Raven 1973; Kay 1971, but cf. Hunn 1976; Randall 1976). In this well-known formulation of the general principles of folk biological classification, plant and animal domains consist of sets of plant and animal taxa arrayed at various taxonomic levels, with lower-level taxa related to higher-level taxa by set inclusion. At the heart of these domains is the "generic partition" (Berlin 1973:262-263; Kay 1971:878-879), a basic set of taxa known to correspond closely with scientific taxa (Hunn 1975a). These core taxa are most frequently biologically natural groupings reflecting genetic discontinuities.

These taxa are also logically natural groupings, which is to say, they are general purpose rather than special purpose concepts. Berlin, Breedlove, and Raven (1966) defined this distinction as follows: "A system of classification is said to be general ('natural' in a logical sense [i.e., polythetic]) insofar as its members possess many attributes in common, and *special* ('artificial' in a biological sense [i.e., monothetic]) when it is based on a few attributes that are of special interest for a particular purpose" (p. 275). Sneath asserts that a general purpose classification will have high information content but "can never be perfect for all purposes," since

when we put together entities with the highest proportion of shared attributes, we debar ourselves from insisting that these entities share any one particular attribute. Thus a special classification is demonstrably the best one for the limited purpose for which it was constructed, a general one the best for a wide range of potential purposes. [quoted in Berlin, Breedlove, and Raven 1966:275]

Biotaxonomists now recognize that membership in a biological species cannot be predicated on possession of a set of necessary and sufficient features. Biological taxa are polythetic, not monothetic. Members of a species rather exhibit a family resemblance consequent on their participation in the species' gene pool. Thus biologically natural groupings will be defined by a high degree of shared resemblance rather than by some defining set of conditions (Simpson 1961:23-28). It is worth noting that this shared resemblance—a relation of similarity—is consequent to and expresses shared inheritance—a relation of contiguity (ibid.:27).

Biologically natural groupings, whether in folk or in scientific taxonomies, being polythetic, will also be general purpose concepts, useful in a variety of contexts. This necessity is apparent only if we recognize that there is structure in nature as well as in culture. Aristotle noted that in classifying nature it is best to "carve at the joints," in other words, to respect the structure inherent in the *pièce de résistance*. I have argued that human perception is programmed to recognize patterns of covariation among the variable dimensions by which perception of a set of objects is organized; the more readily recognized, the stronger the covariation, other things being equal (Hunn 1975b, 1976, 1977). In the case of our recognition of patterns among living organisms, the facts of genetic transmission and natural selection all but guarantee that genetic discontinuities, which define species populations within a restricted ecological community, will be reflected in cultural classification via the application of panhuman perceptual algorithms.

This is no doubt also true for nonhuman animals. Vervet monkey alarm calls, for example, differentiate among leopards, martial eagles, baboons, and pythons as predators and elicit distinct evasive responses in wild monkeys (Seyfarth, Cheney, and Marler 1980). Lions are known to exhibit a variety of hunting strategies as a function of the prey species. If they did not, they would certainly be clumsy hunters. The genetic discontinuities that underlie natural classification are also expressed in consistent chemical and behavioral covariation among the individuals of a species which are highly relevant to interspecies interactions, including, of course, those to which human beings are party.

Our presumably innate propensity to "see" biologically natural categories allows our behavior to be flexible in a highly efficient manner. Biologically natural categories, defined genetically, will tend strongly to be categories useful for many human purposes. Species are not only *good to think* (see Tambiah 1969), they are *good to act upon*, since human actions appropriate to one member of such a category are very likely appropriate to any member of that category. We tend to respond to all individuals of a species in like manner. We either eat them or avoid them, use them to make bows or reject them for that purpose, apply them as treatment for boils or seek some other remedy, respect them as spiritually powerful or treat them matter-of-factly. Natural selection has facilitated that most problematic of adaptive tasks, extrapolating from the uniqueness of one's past experience to future encounters with reality. An apparent exception involves categorical uses which require further specification, such as "eating *green* apples may make you sick," or "harvest only the *largest males*." However, such recipes for action nevertheless are predicated on the prior recognition of an appropriate natural category. The qualification specifies a monothetic subset of the polythetic taxon, allowing a more effective adaptive response with minimal added conceptual effort.

#### SELECTING NATURAL DISCONTINUITIES FOR CULTURAL RECOGNITION

At this point, the folk taxonomic model may seem unassailable: a taxonomic hierarchy built on a core of naturally useful distinctions. Unfortunately, it is not so simple. First, there is the fact that the number of discontinuities in nature far exceeds the observed capacity of folk taxonomies. If every visible genetic discontinuity were culturally recognized, there would be room in memory for little else. No more than a small fraction of the potentially useful information about the environment is or could be processed and stored in human memory. For example, the Sahaptin Indians of the Columbia Plateau specifically name only some 200 of 2,000 or more species of vascular plants known to exist in the region they occupy. They name less than a half dozen fungi of more than 1,000 species estimated locally, and name five kinds of beetles, though as many as 4,000 may occur in the region (Hatch 1953-1971). As the Tenejapa Tzeltal will recognize insects at

the species level if motivated to do so (Hunn 1977:259-274), such classificatory detail is within the capacity of the folk taxonomist.

This same information-processing limitation has led some biological taxonomists to conclude that modern science likewise will never achieve an exhaustive inventory of natural species, even with the aid of electronic data storage and retrieval. There are simply too many species and there is too little time, given that biologists are not solely concerned with naming. The alternative, for folk and academic scientists alike, is to impose a selective process based on utility (Raven, Berlin, and Breedlove 1971). For example, Sahaptin speakers, who depend heavily on fish as a staple food, recognize 60% of the native fish species nomenclaturally, but only 25% of the native bird species (Hunn 1979). If we are to explain why a particular subset of the available natural discontinuities is selected for cultural recognition, we must model this selection process. This requires us to consider the practical consequences of knowing or not knowing some plant or animal.

The fact that only a fraction of the potential natural discontinuities may be recognized in a folk biological classification creates theoretical difficulties for the taxonomic model. What is to be done with all those unclassified entities? In some cases they are simply left out of the basic level of classification—there will be *empty regions* in taxonomic “space,” regions where many or all tokens are recognized only in very general terms, for example, as some kind of “bird,” but are not recognized as some *particular* kind, that is, in Berlin’s terms, as a member of a folk generic taxon. The common Tenejapa Tzeltal response to a request for names for the many large and distinctive solitary wasps of their neighborhood provides another example (Hunn 1977: 264, 270). Though extraordinarily adept at classifying social Hymenoptera, Tenejapanecos confess to ignorance of many common solitary species. If pressed for a name, they respond by noting only that the solitary wasp is *kol pahaluk sok šuš* ‘about the same as a [social] wasp.’ (Note that single quotes are used here and below to indicate a gloss of a native concept.) It is as if the informant had never *seen* the creature before (though not for lack of opportunity). This contrast between the detail of classification applied to social as opposed to solitary Hymenoptera may be due to the increased frequency and intensity of encounter between people and the social species of wasps, encounters with varied, but often highly significant, even painful, practical consequences (see Posey 1981).

The empty taxonomic space may also be labeled as a *residual category*, which is a convenient linguistic means to dismiss all organisms deemed not worth recognition on their own account. For example, the John Day Sahaptins of the Columbia Plateau of northwestern North America use the term *cik<sup>w</sup>ácik<sup>wa</sup>* ‘dicky bird,’ for any smallish bird not otherwise named. Note that this label is *not* appropriate for otherwise similar species which have “proper” names, such as the chickadees, called *latítalwit*, an onomatopoeic rendering which also indicates the bird’s role in myth as harbinger of the modern age. A great many species of herbaceous plants are similarly dismissed with the phrase *áwtya áy c’íc’k* ‘just a grass,’ or *áwtya áy latít* ‘just a flower.’ However, useful ‘grasses’ and ‘flowers,’ recognized nomenclaturally as basic level folk taxa, are excluded from the more inclusive categories *latít* and *c’íc’k*. Thus the boundaries of Sahaptin ‘flower’ and ‘grass’ are drawn with respect to practical concerns. For example, Sahaptin speakers ignore most taprooted species of the genus *Lomatium*, calling them ‘just flowers,’ while classifying tuberous-rooted *lomatiums* growing nearby with exemplary finesse. The former are of little use as carbohydrate resources; the latter produce a high energy return for the labor of harvest. The tuberous-rooted species are further classed as *xnít*, ‘edible plants which are dug,’ at a more inclusive taxonomic level (Hunn 1981; Hunn and French 1981).

Sahaptin is certainly not unique in this classificatory pattern. The Northern Paiute of the Great Basin use an extensive inventory of residual categories at various levels of in-

clusiveness (Fowler and Leland 1967). Though residual taxa in Northern Paiute may or may not include basic taxa as subdivisions, Fowler and Leland gloss the terms for these categories in precisely the form appropriate for Sahaptin, for example, 'just flowers,' 'just grass,' 'just willows,' and so forth (p. 390). The Cha-Cha of the Virgin Islands recognize a large, heterogeneous category of fish called *corail* which includes fish on the basis of their "uselessness" for food and their similar patterns of behavior" (Morrill 1967:408). Such categories are strongly reminiscent of folk English "weed."

The examples I have just described do not accord well with the "general principles of folk biological classification" enunciated by Berlin, Breedlove, and Raven (1973) nor with the associated formal taxonomic model (Kay 1971). As noted above, that scheme requires a structure of sets of organisms related to one another by set inclusion and defines the generic partition as a set of mutually exclusive taxa that *jointly exhausts the domain*. These folk generic taxa are characterized by Berlin as highly salient psychologically, biologically natural polythetic, general purpose groupings. Taxa that are superordinate or subordinate to the taxa of this generic partition are classified by Berlin into several obligatory folk taxonomic ranks, with *life-form* taxa immediately above and folk *specific* taxa immediately below the generic taxa.

As noted above, Sahaptin 'flower' and 'grass' are residual taxa, that is, groupings of organisms that are alike only by virtue of having been passed over in the process of cultural recognition. They directly contrast with folk generic taxa in the context of naming, for example, "that's not an X, that's just a flower." In fact, they typically substitute for generic names. However, they resemble life-form taxa in that they include a heterogeneous collection of biological species. But they are not life-form taxa by virtue of being "empty," to use Turner's apt phrase (1974:35), lacking folk generic subdivisions. Residual taxa lack the hallmark of taxa at the "generic core" of folk biological domains in that they are not *natural*. They are rather biologically artificial, monothetic, and special purpose concepts. Their special purpose, apparently, is to collectively represent a nonresource. Thus we have taxa that are "neither fish nor fowl" within the presently dominant theory of folk biological classification, and we find that the folk generic taxa fail to fully partition the folk biological domains. Folk generic classification is highly selective, and the practical significance of the organisms classified is important to the selection process.

## TWO COMPETING MODELS OF FOLK BIOLOGICAL CLASSIFICATION

On closer inspection, we see that current folk biological theory is rent by a fundamental contradiction. There are two models of folk biological classification based on contrasting principles, each with a partial claim to represent reality. There is the *taxonomic hierarchy model*, which envisions folk biological domains as sets of taxa at various levels related by set inclusion. This model owes its form to a Linnean analogy and a set theoretic formulation (Gregg 1954; Kay 1971). The notion of *direct contrast* is fundamental to it, a notion derivative of the methodology of structural linguistics. A folk taxonomy of this type is generated by a series of queries of the form, "What are the names of all the kinds of X in Y" (Metzger and Williams 1966:39). The alternate model, which I will call the *natural core model*, sees folk biological domains as composed of a general purpose, polythetic core of taxa surrounded by special purpose, monothetic concepts in peripheral positions. Since this natural core/artificial periphery distinction recognizes the purposiveness of human classification, the model is one of practically motivated reasoning.

Berlin's concept of taxonomic rank (1973:260; 1976:381-383) is an awkward compromise between the two, an attempt to fit the natural, polythetic core of a folk biological

domain into the procrustean bed of a taxonomic hierarchy by interpreting this core as equivalent to a single taxonomic hierarchic rank, the generic partition. The fit is not adequate, as the examples discussed above should make clear. Artificial taxa creep into the generic "partition" as residuals. Nor can natural-core taxa be confined to Berlin's generic taxonomic rank, as such taxa may be found at taxonomic levels both superordinate to and subordinate to his folk generic rank. I have demonstrated that both natural and artificial folk biological taxa may occur at Berlin's folk specific rank (Hunn 1977:53). Here I will show that the same is true of taxa at Berlin's life-form rank, a fact with serious theoretical consequences for the taxonomic hierarchy model of folk biological classification. If there is no necessary correlation between the taxonomic rank of a taxon and its status as natural or artificial, the notion of taxonomic rank is shown to be a purely formal distinction imposed by the analyst.

### PROBLEMS AT THE LIFE-FORM RANK

Brown (1977, 1979) and his colleagues have profitably directed our attention to folk biological taxa of life-form rank, defined by Berlin as "the broadest, most encompassing classification of organisms into groups that are apparently easily recognized on the basis of numerous gross morphological characteristics" (1973:261). In this definition Berlin explicitly includes life-form taxa within the natural core of a folk biological domain. In a later reassessment he revises this view, describing life forms as recognized on the basis of "a small number of " morphological characteristics" (1976:385). Since "a small number" is neither many, that is, polythetic, nor one, that is, monothetic, the relationship between life forms and the polythetic generic core of the domain remains ambiguous. The status of life forms as polythetic or monothetic is the focus of the following critique.

First it should be noted that the distinction between polythetic and monothetic concepts is not solely a question of the number of features relevant to the conceptual distinction. As a general rule, instances of polythetic concepts are *distinguished* by many features while monothetic concepts are *defined* in terms of one or a small set of criterial features (i.e., necessary and sufficient conditions for category membership). But more essential, the monothetic concept is *imposed* on reality by logical fiat, the polythetic concept is *recognized* by virtue of a family resemblance shared by instances of the concept. I have elsewhere labeled these two types of taxa "deductive" and "inductive" respectively (Hunn 1976). Core folk biological taxa are polythetic for the reasons indicated above. Noncore taxa are often "hybrids" in which an organism is first recognized as a bird, fish, snake, or as an example of some core taxon, then classified, for example, as "large bird," "edible fish," "poisonous snake," or "large, blue butterfly," by the subsequent imposition of a criterial feature. Note that "large, blue butterfly" is no less monothetic for requiring the coincidence of two criterial features.

In addition to the number of relevant features, the pattern of variation with respect to the feature(s) is significant. In some cases, features are absolute, for example, wings, legs, or flowers are either present or absent. In other cases, features are relative, for example, size or woodiness is present to some *degree*. In the case of monothetic concepts, the presence, absence, or degree of the criterial feature(s) tends not to correlate with patterns of covariation among other features descriptive of morphological variation within the domain. By contrast, polythetic concepts are bounded by natural discontinuities or "gaps" in the pattern of covariation among large numbers of features. In general, the more encompassing the biological taxon—as in the case of life forms—the less likely the taxon will be bounded by such a gap (Hunn 1977:50). It is also possible, though rarely the case, that a taxon is *both* polythetic and monothetic, if the presence or absence of the criterial feature(s) happens to match the natural gap. The life form 'bird' is an example. The

presence of feathers is a criterial feature that marks the gap of correlated traits such as the presence of wings, two legs, hollow bones, a beak, egg-laying habits, and the capacity for flight, that typify a bird's family resemblance.

Brown argues in a series of recent articles (especially 1977, 1979) that the naming of biological life forms exhibits a universal implicational sequence much like the naming of basic color terms (Berlin and Kay 1969; Kay and McDaniel 1978). According to Brown, the plant and animal domains initially lack named life forms. Terms are then added in a specific sequence. For plants, 'tree' is added first, then 'grass' or "grerb" (Brown's label for a taxon inclusive of 'grass' and 'herb'), then 'bush' and/or 'vine.' For animals, 'fish,' 'bird,' and 'snake' are named first, in any order. Only subsequently are terms for 'mammal' and/or "wug" (his label for a taxon inclusive of 'worm' and 'bug') introduced. Brown's analysis is restricted to these few allegedly universal concepts.

Brown's universalist-evolutionary arguments depend on the validity of a close analogy between the historical development of basic color term vocabulary and that of folk biological life forms. Just as Berlin and Kay's color term analysis rests upon the privileged position of *basic* color terms (1969:5-7), Brown's scheme requires that there exist a definitive set of life-form taxa in each folk biological domain characterized by consistent criteria of content and structure. Berlin has defined the structural prerequisites of life forms: they occur at level one of the taxonomic hierarchy, that is, immediately below the unique beginner or source of the taxonomic tree, and are inclusive of a plurality of folk generic taxa. Consistency of content is explicitly required by Brown's exclusion of taxa based on nonmorphological criteria, such as habitat and use, and of taxa defined in terms of the presence of plant parts, such as berries or flowers (Brown 1977:320; 1979:793).<sup>1</sup> Brown's insistence that life forms be based on "overall morphology" accords with Berlin's assertion that life forms are "recognized on the basis of . . . gross morphological characteristics" (Berlin 1973:261). I will show that these so-called universal life-form taxa represent no consistent type of concept, and that this restriction of life forms to concepts based on "overall morphology" is neither consistently applied nor theoretically justified.

First, there is a striking contrast within Brown's "universal" life-form set between 'bird,' 'fish,' 'snake,' and 'grass,' on the one hand, and "wug," 'mammal,' 'vine,' 'tree,' "grerb," 'herb,' and 'bush,' on the other. Members of the first group, if literally glossed, are biologically natural, and thus polythetic core taxa which reflect dramatic natural discontinuities. The second group, however, includes a set of biologically arbitrary, monothetic, or residual taxa. For example, 'tree' life forms typically reflect large size and woodiness, two highly correlated but continuously varying morphological traits. Size and woodiness are relative characteristics. Thus 'trees' shade imperceptibly into 'bushes' and 'bushes' into 'herbs.' There is no perceptual (and, of course, no underlying phylogenetic) discontinuity motivating the recognition of 'tree.' How then are we to explain the near universal labeling of a concept inclusive of large woody vegetation (Brown 1977: 324-326)?

Perhaps the answer lies in the universal practical value of 'trees' rather than in the perceptual salience of 'tree.' For example, Samal 'tree' (*kayu*) is more accurately glossed 'burnables' (Randall 1977:49). In a comparative study, Witkowski, Brown, and Chase found the same term used for both 'wood' and 'tree' in 44 of 66 cases (1981). While this may be interpreted as polysemy in which the name for the concept 'tree' has been suggested by the name for the concept 'wood,' it is also likely that an aspect of the meaning of 'tree' in many languages is the organism's practical value as a source of burnable wood. Likewise, 'vines' may more faithfully reflect the utility of vinelike plants for bindings than the perception of any purely morphological discontinuity. 'Mammal' is biologically arbitrary for a different reason. This life form is inappropriately glossed in that what is



usually found is a category of large animals not otherwise classified as to life form (a residual), or a category predicated on such biologically arbitrary features as four-footedness, as Brown himself recognizes (1979:793). Thus the life-form rank, like the folk generic and specific ranks, is divided by the fundamental contrast between natural and artificial taxa.

Furthermore, there is a noticeable instability in the apparently natural life forms. Such life forms often are manifest as simplified variants, monothetically defined, which broadly overlap the "natural" life form in denotative range. For example, the natural taxon 'bird,' which is inclusive of all and only those animals scientists place in the vertebrate class AVES, may or may not be the reference point of the folk life form 'bird.' Often the life form we gloss as 'bird' is, in fact, only 'quasi-bird,' a monothetic taxon defined in terms of the capacity for flight or a preference for an aerial habitat. Examples include the Kalam life form *yakt*, which includes bats but excludes the flightless cassowary, a bird (Bulmer 1967, 1974). Northern Paiute *yoziði* includes bats, birds, and flying insects—the last named set apart internally from the subdivision *huziba* 'bird' + 'bat' (Fowler and Leland 1967:386). Samal *manuk-manuk* also includes bats, birds, and flying insects (Randall 1976:49). Such quasi-bird life forms are not "recognized on the basis of numerous [or even of "a small number" of] gross morphological characters" (Berlin 1973:261) nor "on the form of the whole animal" (Brown 1979:793, emphasis in the original). Thus they reflect principles of classification inconsistent with those Berlin and Brown use to characterize the life-form rank.

The 'fish' life form may include aquatic invertebrates also, as in Tzeltal *čay* (Hunn 1977:250–254), or cetaceans and cuttlefish, as among the Hong Kong boat people (Anderson 1967). 'Fish' in these cases is clearly monothetic, defined not strictly in terms of overall morphological resemblance, but rather in terms of aquatic habitat. 'Snake' life forms on closer inspection may be seen to be inclusive of all animals which 'crawl,' as in Northern Paiute *nuyuadi*, which includes a variety of nonflying insects as well as lizards and snakes, or they may harbor a menagerie such as Ndumba *kaapa'raara*, which includes snakes, lizards, eels, centipedes, and worms (Hays 1980:17–18). 'Grass' may be equivalent to the scientific family Graminae, characterized by a complex of covariant traits including linear, parallel-veined sheathing leaves and apetaloid inflorescences adapted for wind pollination.<sup>2</sup> However, the 'grass' life form is frequently extended to include dicotyledonous plants such as herbaceous amaranths and chenopods. These have superficially grasslike inflorescences, lacking the showy 'petals' essential to the folk concept of 'flower.' In Sahaptin, for example, *c'ic'k* 'grass,' includes all herbaceous plants which are not 'flowers,' unless they are otherwise named. Since all such named plants have recognized practical utility, the meaning of Sahaptin 'grass' includes the signification 'not useful.'

This last qualification is widespread. Life forms are often residual with respect to practical significance. Examples include the very Tzeltal plant life forms which inspired Berlin's statement of general principles. Tzeltal 'grass' excludes three species of the genus *Lasiacis* (Graminae) while including two others of that genus. Those excluded are considered culturally "significant," while those included in the 'grass' life form are considered culturally "unimportant" (Berlin, Breedlove, and Raven 1974:405, 424–429). The Tzeltal life forms 'vine' and 'herbaceous plant' also require such a special purpose specification, much as does our folk English concept "weed."<sup>3</sup> This intrusion of practical considerations into the referential meaning of life forms is anomalous from the taxonomic perspective in that it divides species that exhibit strong morphological resemblances while uniting others that are morphologically dissimilar.

In sum, the delineation of a privileged set of heterogeneous folk biological taxa distinguished by their general morphological signification is shown to be a very problem-

atical task. The best examples of such "life forms" are taxa that faithfully reflect natural discontinuities (exhibit clear "criteria clustering" in Brown's terminology [1979:806]). These are simply core taxa of exceptional heterogeneity, and their developmental priority (ibid.:801) is due to their perceptual salience, the same cognitive principle that underlies the recognition of folk generic taxa (Hunn 1976). Such taxa should not be "lumped" with monothetic "life forms," which appear to conform but rarely to the overall morphology criterion.

Furthermore, Brown arbitrarily restricts his analysis to a small set of folk biological concepts prejudged to be universal. It is with respect to this small set that the developmental progress of a language is evaluated. Consequently, we are left in ignorance of the welter of utilitarian and ecologically defined suprageneric taxa which most peoples rely on to organize their knowledge of the natural world. For example, Sahaptin is judged a very simple system because it is credited with but one reasonably unambiguous botanical life form, 'tree.' Yet Sahaptin conversation is full of reference to such general classes of plants as *xnit* 'food plants which are dug,' and *tmaanit* 'food plants which are picked.' The utility of the plants in each of these categories depends upon morphological specializations of the included plants, underground starch storage organs in the case of most *xnit*, attractive fruit in the case of most *tmaanit*, just as 'tree' is notable for its burnable wood.

Brown has analyzed a shred from the larger and far more complex fabric of folk biological thought. His impressive body of comparative data is clearly patterned. However, the full significance of that pattern will remain obscure until we understand the interaction of core and peripheral classificatory principles. That task requires that we pay close attention to the practical context of folk biological knowledge systems.

#### METHODOLOGICAL SUGGESTIONS FOR ASSESSING THE PRACTICAL SIGNIFICANCE OF TAXA

Previous studies of ethnobiology may be described as either preethnoscience or ethnoscientific (see Hays 1974:100-110). Preethnoscience ethnobiology was primarily concerned with the practical value of native distinctions. The typical ethnobiological account of this period is a list of scientific species known to the people of culture X, with a summary of native uses under each species' heading. There is much useful data in these accounts relevant to a variety of theoretical issues; however, such studies lack intrinsic theoretical focus. They have generated no cross-cultural syntheses.

Ethnoscientific ethnobiology has focused on the task of defining the principles of folk biological classification and naming. The works of Berlin and Brown reviewed above represent this tradition of ethnobiological research. These authors have not entirely ignored the practical value ("cultural significance" in Berlin's terms) of folk biological knowledge. For example, Berlin, Breedlove, Laughlin, and Raven (1973) analyzed the correlation between "Cultural Significance and Lexical Retention in Tzeltal-Tzotzil Ethnobotany." Cultural significance was rated on a crude scale having four values, "cultivated," "protected," "wild but useful," and "culturally insignificant." Names for the more significant plants changed less rapidly. Brown has noted that "cultural significance" is an effective determinant of the content of life form inventories. He explains the correlation between the stage of growth of a life-form inventory and a culture's societal complexity score by reference to the progressively reduced reliance in complex societies on detailed knowledge of specific plants and animals (Brown 1977:332; 1979: 804-805), a connection first suggested by Berlin (1972; cf. Dougherty 1978).

What is striking in these ethnoscientific treatments of the practical significance of folk biological knowledge is their ad hoc quality. The methodological sophistication so pro-

ductively employed to define referential meaning and formal structure in the folk biological domains is nowhere apparent when uses are considered. It is time we created a postethnoscience ethnobiology, using the best ethnoscience ethnography to record and analyze the practical value of ethnobiological knowledge.

The first task of postethnoscience ethnobiology is to systematically describe the practical significance of each taxonomic distinction. Then, perhaps, we may learn to measure that significance. The range of questions we might address if we had a valid measure of the practical significance of taxa is impressive. For example, I have previously proposed that we measure the perceptual salience of a taxon and test the power of such a measure to predict the selection of natural discontinuities for nomenclatural recognition (1977: 72-75). Berlin, Boster, and O'Neill (1981) have conducted such a test and found perceptual salience a highly significant predictor of nomenclatural recognition among Aguaruna Jivaroan bird classification. Yet they also found a large residual variance. The multiple  $r^2$  of linguistic codability with perceptual salience + size was 0.32, thus 68% of the variance in codability remains unaccounted for by these two perceptual factors. How much of that residual might be accounted for by the relative practical significance of the birds in question? With such a measure we might evaluate predictions as to changes in the content of folk biological classifications on the basis of changes in patterns of resource use. Working backward we could assess the significance of a class of resources, say, of roots, or fish, or game, on the basis of the nomenclatural elaboration within each class, having controlled for perceptual salience. This could provide a more precise basis for reconstructing defunct ecological patterns from folk biological knowledge still extant in the memories of the survivors of acculturation.

Yet measuring practical significance is easier said than done. Crude indexes, of course, have been applied with some success. For example, Jochim has offered a variety of ecological predictions for hunter-gatherers in an archeological context based on a measure constructed of six factors: weight, density, aggregation size, mobility, fat content, and nonfood yields of prey species. These factors are rather arbitrarily combined in a single formula (1976:23). Foraging strategies attempt to predict utilitarian preferences using caloric yields as a standard (Smith 1979). Economists apply a monetary standard, though recognizing that "utility" is a nonlinear function of monetary value. Sociobiologists postulate inclusive fitness differentials as the measure of alternative cultural inventories (Cavalli-Sforza and Feldman 1973; Durham 1976). Closer to the present ethnobiological context is Lee's typology of !Kung San plant resources as primary, major, minor, supplementary, rare, and problematic (1979:169-170). Berlin's distinction among cultivated, protected, wild but useful, and culturally insignificant plants is of this type.

Though adequate for limited hypothesis testing, such schemes will be restricted in their relevance to particular domains, particular types of economy, or particular definitions of "practical significance." To transcend these limitations, I believe it is essential to specify practical significance from the native point of view. In the tradition of ethnoscience methodology we should first seek to understand the particular cultural system in its own terms, then seek to generalize. Hays has pursued this task of measuring the cultural significance of taxa from the native point of view as far as anyone to date (1974). He compiled a list of 269 uses cited by his Ndumba informants for plants and assigned each of 458 plant taxa to the appropriate indigenous use categories based on the judgments of a sample of informants. He recognized the problems raised by functional equivalence; that is, certain plants are uniquely appropriate for certain purposes while others may be but one of a large set of acceptable sources of material, as in the case of firewood. Hays was disappointed to find little apparent correlation between his utility measures and target variables such as nomenclatural agreement among informants. Nor did he find close

agreement between his measures and Berlin's framework cited above for classifying the cultural utility of Tzeltal plant taxa (Hays 1974:196-201).

Hays's measures, though systematic and ambitious in scope, are not yet adequately descriptive of local use patterns. For example, he cites "tuber eaten" as one use with 85 functional equivalents. A comparison with Sahaptin is instructive. The Sahaptin taxon *xnít*, 'edible plants which are dug,' includes some 35 folk taxa. "Tuber eaten" is an appropriate functional gloss for all. However, no two such taxa are precisely alike with regard to how, when, and where they are used and who makes use of them. In fact, we may propose the working hypothesis that no two folk biological taxa, if their practical significance were adequately described, would be found to be precise functional equivalents. Our task, then, is to describe the practical context of folk biological knowledge in detail sufficient to discriminate each taxon from every other. Each taxon should be definable in terms of a unique *activity signature*.

#### ACTIVITY SIGNATURES OF FOLK BIOLOGICAL TAXA: A PRELIMINARY SKETCH

To suggest the scope of information necessary to characterize an activity signature, let us examine more closely one highly salient Sahaptin "practical life form," *xnít*, introduced above. As already noted, this term subsumes some 35 core folk botanical taxa. The name is a verbal noun derivative of *xní-* 'to dig plant foods.' Excluded are closely related plants which are not foods, for example, *Lomatium gormanii* (for those who consider it inedible), or plants which are foods but not 'dug,' for example, *L. nudicaule*, which has edible stems but roots which are not eaten. The category is meaningful in several important practical contexts. For example, *xnít* contrasts with *tmaanít*, 'edible plants which are picked,' in terms of the tools typically employed, that is, digging sticks and soft-twined baskets for *xnít*, hands and coiled root or bark baskets for *tmaanít*. These two taxa together evoke the seasonal rhythm of the Sahaptin food quest, with *xní-* an activity typical of spring, *tmaaní-* 'to pick plant foods' an activity of summer and fall. Each of these basic gathering activities involves a separate progressive upslope movement (Hunn and French 1981). Thanksgiving feasts ritually punctuate this seasonal round. Such feasts always incorporate the sacred foods: *núsux* 'salmon,' one or more kinds of *xnít*, one or more kinds of *tmaanít*, and *čúuš* 'water.' (The linguistic and ritual variant described here applies in particular to the Columbia River dialects of Sahaptin spoken from Rock Creek, Washington, to Umatilla, Oregon.)

Though the concept *xnít* is clearly instrumental in conceptually ordering the Sahaptin peoples' annual schedule of subsistence activities, it is insufficiently precise for most day-to-day contexts. It is a special purpose concept of limited relevance. If one inquires, 'What are the women doing?' it would not be inappropriate to respond, 'they're root digging' (*paḡníša*). Such an answer is far from adequate, however, as a "recipe for action." One may infer the need for digging sticks and twined baskets from that response, but one would not know where the women had gone nor for how long, nor what processing activities necessarily follow the 'digging,' unless, of course, one is already privy to the implicit knowledge of seasonal associations and personal histories sufficient to "read between the lines." For example, if the women have gone to Oregon and it is early May, they are almost certainly digging *xáwš* 'cous' (*Lomatium cous*). 'What are they digging?' provides a wealth of additional information by specifying the relevant core folk taxon. With each possible response comes a unique set of practical implications. It is this set of implications that constitutes an *activity signature*.

Likely responses to the query, 'What are you digging?' include: *pyaxí* 'bitterroot,' *xáwš* 'cous,' *lúkš* '*Lomatium canbyi* in part,' *škúlkul* '*L. canbyi*, another part,' *maxšní* '*L.*

*farinosum* var. *hambleniae*,' *mámín* 'L. *piperi*,' *púia* 'L. *macrocarpum*,' *pank'ú* 'Tauschia *hooveri*,' and *xmáš* 'camas.' Within this set are plants harvested on 'lithosols' (*šám*) and others harvested in 'vernal meadows' (*táay*). Some are 'shallow' and easy to dig; others are 'deep,' such as *púia*, rarely dug today in part because of the labor required to dig it out. Some *xnit* are generally available (within appropriate habitat); others are available only in certain restricted regions or at certain sites, e.g., *xáwš* is an 'Oregon root,' *škúlkul* and *maxšni* are 'Priest Rapids roots,' and *pank'ú* is a 'Yakima root.' Some, such as *maxšni*, are dug only by children.

Lithosol species are available early to late spring depending primarily on elevation, but also on exposure to sun and drying winds, the precise timing also a function of weather patterns, constantly monitored by the people. 'Maturity' of a species is dependent on factors that vary from species to species. For example, tuberous lomatiums (an unnamed and unrecognized category in Sahaptin) are typically preferred as the petals drop. Before that time they are often found to be too 'soft.' Shortly after the petals drop, the plant may be 'burned,' and the tops dry and blow away, effectively hiding the roots. 'Bitterroot' is preferred before the buds open, as subsequently the bitter 'bark' of the roots is difficult to peel, and processing time increases to discouraging levels.

Processing strategy is perhaps the most salient dimension of variation differentiating these folk taxa. 'Camas' must be baked underground for from one to three days, which normally implies a complex, cooperative effort on the part of several women (and of men also, as quantities of firewood, rocks, and so forth, are required at the processing site). It has been shown that this processing significantly enhances the nutritional value of camas (Konlande and Robson 1972). Camas is harvested less often today in part, I suspect, because of the increasing difficulty of organizing the processing tasks. 'Tauschia *hooveri*' is a great favorite—root-diggers traveling from three states to harvest a supply—in part because it is delicious raw, requiring no processing. The most subtle distinction (from the scientific botanist's perspective) drawn by Sahaptin speakers is that between *škúlkul* and *lúkš*. These terms label a partition of the botanical species *Lomatium canbyi*. The folk forms are identifiable on the basis of morphological cues, for example, the texture of the leaves, the size and shape of the tuberous root, the color and 'oiliness' of the root in cross-section (see Washington 1976). Yet both forms occur in the same habitat, mature at the same time, and are dug in the same way. There would seem insufficient practical motive to separate them (and their perceptual salience is vanishingly small). Yet contemporary Yakima Indians not only emphatically distinguish them; they will travel 200 km to dig *škúlkul*, while *lúkš* is found in abundance near their homes. A sharp distinction is drawn in terms of appropriate processing, that is, *lúkš* is dried or ground and mixed with *mámín* '*Lomatium piperi*' to form finger cakes. By contrast, the more oily *škúlkul* should be baked underground like camas. It is thus a very different food and contributes substantially to the Yakima's perception of culinary variety. Also highly significant are the sociopolitical associations. *škúlkul* is a 'Priest Rapids people's root.' One may speculate that its cultural value at Yakima may reflect the value of extended kinship ties, which constituted the sociopolitical foundation of the Plateau subsistence strategy (Marshall 1977).

I have sketched only the bare outline here of the relevance of folk biological distinctions for practical affairs. Such an account requires that folk biologists ask not just what the names for things are, but also the who, what, when, why, and how which define their practical significance. This involves no radically new methodology. It simply requires that our ethnobiological queries be as systematic and exhaustive with regard to the behavioral relevance of terms as to their denotative meaning. Once we have learned to describe the activity signatures of folk taxa, we will be in a much better position to appreciate why one group of organisms is more highly differentiated than another, why one culture concentrates here, another there, within their respective floral and faunal

"spaces." We will better understand what underlies taxonomic variation within a culture, and how changes in folk biological knowledge affect the environment (and vice versa). However, description is not an end in itself. It is a first step toward theoretical generalization. Our next step is to analyze the role of an activity signature in the larger cultural system. This requires that the analysis of folk biological classification be joined with an effort to characterize formally the routine action plans which link thought and action.

#### ACTIVITY SIGNATURES AND ROUTINE ACTION PLANS

One might define the activity signature of plant or animal X as the set of all culturally valid imperative sentences in which the noun X occurs as object. Such sentences may be seen as instructions to act, for example, "bake camas in the underground oven for three days." One might compare taxon X with taxon Y by counting the number of such sentences in each activity signature, but this would surely be a poor way to measure the relative practical significance of taxa. All sentences of an activity signature are not equally significant. The task of evaluating the practical significance of recognizing taxon X leads us to assess the significance of a particular instruction to act within the larger strategy for living which defines a particular culture.

Two recent analyses of cultural plans suggest how this might be accomplished. Geoghegan's seminal though still unpublished analysis of Tagtabon residence choice shows the feasibility of such a program. His cultural model is composed of a sequence of assessments, for example, age, marital status, viability of household, house ownership, economic means, which collectively determine in culturally appropriate terms the "proper" mode of residence for an individual. Though of modest scope, this model passes the behavioral test with high marks. It predicts with 98% accuracy the choice of residence mode of several hundred individuals in two populations of Philippine Samal (Geoghegan 1969). His model is formally explicit, informed by cognitive psychological research, and faithful to the native rationale (Geoghegan 1973). The variety of residence choices is shown to follow from a single cultural rule. Geoghegan illustrates how changes in rule-generated behaviors in a community may result without changes in the rule itself. Such rules may "evolve" in response to environmental changes.

Randall has completed an ambitious analysis of Samal fishing (1977) that extends Geoghegan's approach to a human context as complex and fundamental as 'making a living.' Though Randall does not attempt an empirical verification of his model, he defines the hierarchical organization of over 300 explicit Samal instructions-to-act necessary to the conduct of nocturnal multi-hook scad fishing, the primary mode of production among the Linungan Samal. In Randall's analysis, the relative significance of an instruction to act is a function of several considerations, including the number of alternative means to accomplish a particular element of the larger plan, the preference ranking of optional realizations of a subplan, and the hierarchic level of an instruction to act within the total plan. For example, an effective medicine which may cure a debilitating illness makes possible a large number and variety of essential activities otherwise impossible. Thus, plans to sustain health are broadly ramifying. By contrast, instructions to harvest a rare and little favored berry have but minor ramifications, under routine conditions.

Geoghegan and Randall show us how culture *works*, how ideas about the world may affect our choice of action in the world, and how a varied and changing world, via cultural assessments, generates behavioral choices well adapted to environmental circumstances. The practical value of an element of folk biological knowledge is a function of its role in the cultural plan that generates adaptive behavior.

## CONCLUSION

I have argued that ethnoscientific research in ethnobiology should be guided by the premise that cultural knowledge is adaptive. In pursuit of this objective, students of folk biological classification must systematically investigate the practical significance of folk biological knowledge. I argue that our theoretical accounting of folk biological classification is hampered by the contradictions between a taxonomic hierarchy model of folk biological classification and one based on the distinction between the natural core and artificial periphery of such classification systems. The latter model is predicated on the fundamental distinction between general purpose and special purpose concepts. From the perspective of the core-periphery model, taxonomic anomalies such as residual taxa and empty portions of the generic partition are resolved and the selective cultural recognition accorded taxa within the core is more fully explained.

Brown's hypothetical sequences for the naming of folk botanical and zoological life forms is questioned, since his scheme presumes that life forms—originally defined taxonomically—constitute a privileged set of concepts free of practical signification. I show that some life forms are natural taxa, but that most belong on the artificial periphery of a folk biological domain. Thus a set of morphologically "pure" life forms cannot be recognized universally as distinct from the variety of practically motivated categories by which core taxa are most often conceptually organized by folk systematists.

I then discuss the advantages of and obstacles to reliable measurement of the cultural utility of folk categories. As a proximate goal I outline a method for describing the *activity signatures* of folk taxa. Such a detailed description of a concept's practical relevance presumes a systematic, native language characterization of cultural plans as recipes for action. This seems a most promising frontier of scientific anthropology, integrating cognitive, linguistic, ecological, and evolutionary theory to define a dynamic ethnology.

## NOTES

*Acknowledgments.* My research on Sahaptin ethnobiology, which has informed much of this discussion, was made possible by grants from the National Science Foundation (BNS 76-16914), the Melville and Elizabeth Jacobs Research Fund (Whatcom Museum Foundation), and the Graduate School Research Fund (University of Washington). I benefited greatly from logistic support in the field from the Kamiakin Research Institute of the Yakima Indian Nation and from correspondence with B. Rigsby. I would especially like to thank my expert Sahaptin consultants, too numerous to single out here. James and Elsie Selam, Sara Quaempts, Elsie Pistolhead, and the late Don Umtuch testified in depth to the sophistication and scope of Native American knowledge of the natural environment in the Columbia Plateau. This paper was originally presented to the symposium, *Renewing the New Ethnography*, organized by J. Dougherty, at the American Anthropological Association Annual Meetings, Washington, D.C., December 2, 1980. This revision has profited from the critical evaluations of B. Berlin, C. Brown, R. Bulmer, J. Dougherty, R. Ellen, D. French, T. Hays, J. Howe, B. Meilleur, R. Randall, E. Smith, D. Spain, and N. Williams. If my treatment here of my mentor, B. Berlin, seems harsh, it is not for lack of appreciation of his contribution. More than anyone, Berlin has made of ethnobiology a challenging theoretical frontier.

<sup>1</sup> Brown asserts that this consistency of life-form content is an empirical finding. However, the consistency is clearly *imposed* by his analysis.

<sup>2</sup> Except for technical details, this complex of morphological characteristics could as well describe grass relatives such as sedges (Cyperaceae) and rushes (Juncaceae). Thus the folk life form 'grass' typically extends to include all such "graminoids." Such a life form is still best construed as polythetic and biologically natural.

<sup>3</sup> Note the similarity of life-form taxa such as those just described, which are residual with respect to utility, and residual "generic" taxa such as Sahaptin *ciik<sup>w</sup>ácik<sup>w</sup>a* 'dickey bird.' Brown and

Chase, in a recent report of their Zapotec research (1981), in fact, suggest that life forms may evolve from residual "generic" taxa such as those I have described above for Sahaptin.

## REFERENCES CITED

- Anderson, Eugene N.  
1967 The Ethnoichthyology of the Hong Kong Boat People. Ph.D. dissertation, University of California, Berkeley.
- Berlin, Brent  
1972 Speculations on the Growth of Ethnobotanical Nomenclature. *Journal of Language and Society* 1:63-98.  
1973 Folk Systematics in Relation to Biological Classification and Nomenclature. *Annual Review of Ecology and Systematics* 4:259-271.  
1976 The Concept of Rank in Ethnobiological Classification: Some Evidence from Aguaruna Folk Botany. *American Ethnologist* 3:381-399.
- Berlin, Brent, Dennis E. Breedlove, Robert M. Laughlin, and Peter H. Raven  
1973 Cultural Significance and Lexical Retention in Tzeltal-Tzotzil Ethnobotany. *In Meaning in Mayan Languages*. Monroe S. Edmonson, ed. pp. 143-164. The Hague: Mouton.
- Berlin, Brent, Dennis E. Breedlove, and Peter H. Raven  
1966 Folk Taxonomies and Biological Classification. *Science* 154:273-275.  
1973 General Principles of Classification and Nomenclature in Folk Biology. *American Anthropologist* 75:214-242.  
1974 Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-Speaking People of Highland Chiapas. New York: Academic Press.
- Berlin, Brent, James S. Boster, and John P. O'Neill  
1981 The Perceptual Bases of Ethnobiological Classification: Evidence from Aguaruna Jívaro Ornithology. *Journal of Ethnobiology* 1:95-108.
- Berlin, Brent, and Paul Kay  
1969 Basic Color Terms: Their Universality and Evolution. Berkeley: University of California Press.
- Boster, James S., and Chad K. McDaniel  
1979 Untitled. Paper presented to the conference on Anthropology, Psychology, and Cognitive Structures, University of California, Riverside, May 1979.
- Brown, Cecil H.  
1977 Folk Botanical Life-Forms: Their Universality and Growth. *American Anthropologist* 79:317-342.  
1979 Folk Zoological Life-Forms: Their Universality and Growth. *American Anthropologist* 81:791-817.
- Brown, Cecil H., and Paul K. Chase  
1981 Animal Classification in Juchitan Zapotec. *The Journal of Anthropological Research* 37:61-70.
- Bulmer, Ralph N. H.  
1967 Why is the Cassowary not a Bird? *Man* 2(N.S.):5-25.  
1974 Folk Biology in the New Guinea Highlands. *Social Science Information* 13:9-28.
- Cavalli-Sforza, L., and M. W. Feldman  
1973 Models for Cultural Inheritance, I: Group Mean and Within Group Variation. *Journal of Theoretical Population Biology* 4:42-55.
- Dougherty, Janet W. D.  
1978 Salience and Relativity in Classification. *American Ethnologist* 5:66-80.
- Durham, William H.  
1976 The Adaptive Significance of Cultural Behavior. *Human Ecology* 4:89-121.
- Fowler, Cathryn S., and Joy Leland  
1967 Some Northern Paiute Native Categories. *Ethnology* 6:381-404.
- Geoghegan, William H.  
1969 Residential Decision-Making among the Eastern Samal (with Addendum on Refugee Population). Department of Anthropology, University of California, Berkeley.



- 1973 Natural Information Processing Rules: Formal Theory and Applications to Ethnography. Monograph No. 3. Berkeley: Language-Behavior Research Laboratory, University of California.
- Gregg, John R.  
1954 The Language of Taxonomy, an Application of Symbolic Logic to the Study of Classificatory Systems. New York: Columbia University Press.
- Handy, E. S. C., and M. K. Pukui  
1953 The Polynesian Family System in Ka-'u, Hawai'i. *Journal of the Polynesian Society* 62: 123-168.
- Hatch, Melville H.  
1953-1971 The Beetles of the Pacific Northwest. Five Volumes. Seattle: University of Washington Press.
- Hays, Terence E.  
1974 Mauna: Explorations in Ndumba Ethnobotany. Ph.D. dissertation, University of Washington, Seattle.  
1980 Animal Classification and Nomenclature in Ndemba, Papua New Guinea Highlands. Department of Anthropology and Geography, Rhode Island College, Providence, xerox.  
1982 Utilitarian/Adaptationist Explanations of Folk Biological Classification: Some Cautionary Notes. *Journal of Ethnobiology* 2:89-94.
- Hunn, Eugene S.  
1975a A Measure of the Degree of Correspondence of Folk to Scientific Biological Classification. *American Ethnologist* 2:309-327.  
1975b Cognitive Processes in Folk Ornithology: The Identification of Gulls. Working Paper No. 42. Berkeley: Language-Behavior Research Laboratory, University of California.  
1976 Toward a Perceptual Model of Folk Biological Classification. *American Ethnologist* 3: 508-524.  
1977 Tzeltal Folk Zoology: The Classification of Discontinuities in Nature. New York: Academic Press.  
1979 Sahaptin Fish Classification. *Northwest Anthropological Research Notes* 14:1-19.  
1981 On the Relative Contribution of Men and Women to Subsistence Among Hunter-Gatherers of the Columbia Plateau: A Comparison with *Ethnographic Atlas* Summaries. *Journal of Ethnobiology* 1:124-134.
- Hunn, Eugene S., and David H. French  
1981 *Lomatium*: A Key Resource for Columbia Plateau Native Subsistence. *Northwest Science* 55:87-94.
- Jochim, M. A.  
1976 Hunter-Gatherer Subsistence and Settlement: A Predictive Model. New York: Academic Press.
- Jones, N. Blurton, and Melvin J. Konner  
1976 !Kung Knowledge of Animal Behavior. In *Kalahari Hunter-Gatherers*. Richard B. Lee and Irven DeVore, eds. pp. 325-348. Cambridge: Harvard University Press.
- Kay, Paul  
1971 Taxonomy and Semantic Contrast. *Language* 47:866-887.  
1975 A Model-Theoretic Approach to Folk Taxonomy. *Social Science Information* 14: 151-166.
- Kay, Paul, and Chad K. McDaniel  
1978 The Linguistic Significance of the Meanings of Basic Color Terms. *Language* 54: 610-646.
- Konlande, J. E., and J. R. K. Robson  
1972 The Nutritive Value of Cooked Camas as Consumed by Flathead Indians. *Ecology of Food and Nutrition* 2:193-195.
- Lee, Richard B.  
1979 *The !Kung San: Men, Women, and Work in a Foraging Society*. London: Cambridge University Press.
- Lévi-Strauss, Claude  
1966 *The Savage Mind*. Chicago: University of Chicago Press.

- Lewontin, Richard C.  
1978 Adaptation. *Scientific American* 239(3):212-230.
- Marshall, Alan G.  
1977 Nez Perce Social Groups: An Ecological Interpretation. Ph.D. dissertation, Washington State University, Pullman.
- Metzger, Duane, and Gerald E. Williams  
1966 Some Procedures and Results in the Study of Native Categories: Tzeltal Firewood. *American Anthropologist* 65:389-407.
- Morrill, William T.  
1967 Ethnoichthyology of the Cha-Cha. *Ethnology* 6:405-416.
- Posey, Darrell  
1981 Wasps, Warriors and Fearless Men: Ethnoentomology of the Kayapo Indians of Central Brazil. *Journal of Ethnobiology* 1:165-174.
- Randall, Robert A.  
1976 How Tall is a Taxonomic Tree? Some Evidence for Dwarfism. *American Ethnologist* 3:543-553.  
1977 Change and Variation in Samal Fishing: Making Plans to 'Make a Living' in the Southern Philippines. Ph.D. dissertation, University of California, Berkeley.
- Raven, Peter H., Brent Berlin, and Dennis E. Breedlove  
1971 The Origins of Taxonomy. *Science* 174:1210-1213.
- Rosch, Eleanor  
1978 Principles of Categorization. In *Cognition and Categorization*. E. Rosch and Barbara B. Lloyd, eds. pp. 27-48. Hillsdale, New Jersey: Erlbaum.
- Ross, Erik B.  
1978 Food Taboos, Diet, and Hunting Strategy: The Adaptation to Animals in Amazon Cultural Ecology. *Current Anthropology* 19:1-16.
- Seyfarth, R. M., D. L. Cheney, and P. Marler  
1980 Monkey Responses to Three Different Alarm Calls: Evidence of Predator Classification and Semantic Communication. *Science* 210:801-803.
- Smith, Eric A.  
1979 Human Adaptation and Energetic Efficiency. *Human Ecology* 7:53-74.
- Simpson, George G.  
1961 *Principles of Animal Classification*. New York: Columbia University Press.
- Tambiah, S. J.  
1969 Animals are Good to Think and Good to Prohibit. *Ethnology* 8:423-459.
- Turner, Nancy J.  
1974 Plant Taxonomic Systems and Ethnobotany of Three Contemporary Indian Groups of the Pacific Northwest (Haida, Bella Coola, and Lillooet). *Syesis* 7, Supplement No. 1.
- Washington, Nat W.  
1976 *Tsukulotsa (Lomatium canbyi): Key to Understanding Central Washington Nonriverine Archaeology*. Paper presented to the 29th Annual Northwest Anthropological Conference, Ellensburg, Washington, April 10, 1976.
- Witkowski, Stanley R., Cecil H. Brown, and Paul K. Chase  
1981 Where Do Tree Terms Come From? *Man* 16 (N.S.):1-14.