A Review of Hierarchical Representation of Ethnobiological Knowledge

April, 1996

by Katharine Grantham
Research Assistant
School of Agriculture and Forest Sciences
University of Wales, Bangor

A review of hierarchical representation of ethnobiological knowledge

Introduction

Simon (1973) described a hierarchy as "a partial ordering, specifically, a tree". The complexity of systems is often found to be hierarchical (Simon, 1962); as a system grows in size and complexity, it will reach a limit where a new level of hierarchical control is necessary if the system is to function reliably (Pattee, 1973). The hierarchical structuring of a knowledge-base, with statements at any one level summarised as fewer units with less detail in the level above and explained by more statements at greater detail in the level below (Allen and Starr, 1982) can be considered analogous that of a living organism, whose functioning is dependant on the organisation into tissues and organs, to cells, to macromolecules, to organic compounds and so on (Simon, 1973). In both cases the utility of a hierarchical organisation rests on its bringing about a greater functional simplicity (Pattee, 1973). This review will first consider how classification as a means of perceiving the environment tends to be hierarchical (Walker, 1994), and later, discuss how hierarchical structuring has been used in the representation of indigenous knowledge

Principles of classification

Classification is forced on us by the limitations of the brain. Human thought, as reflected in human language, appears to be greatly dependant on the recognition of groups, particularly groups which comprise collective nouns. For example '*tree*' involves two mental processes: first, the similarities which trees possess; and second, the differences between trees and non-trees (Clifford and Stephenson, 1975). Classification encompasses at least two other concepts: dissection (the formation of non-overlapping groups defined by fixing boundaries in a continuous distribution) and identification (the location of an individual within a group).

For biological classification as a whole we have devised a hierarchical system of grouping (and later naming) species: the binomial system. This system is based on a series of hierarchical categories of the nesting box type with organisms grouped according to their structural attributes. There are two kinds of relationships which can be used to give general groupings: association by similarity (generally known as systematics or taxonomy) and association by contiguity (Simpson, 1961). Monothetic divisive approaches to classification involve subdivision of the entities to be classified by one attribute after another considered in sequence. Polythetic agglomerative approaches aggregate individuals into groups on the basis of their overall similarity with respect to several attributes considered simultaneously. In practice taxonomic systems have usually evolved from the application of both approaches.

Both taxonomic and ecological classification attempt to divide ostensibly continuous systems into discrete entities and compress multidimensional relationships into two-dimensional models (Clifford and Stephenson, 1975). Combinations of a small number of attributes are usually employed in describing the taxa, and descriptions of taxa are based on fidelity and constancy of these attributes. Complete fidelity means that an attribute is exhibited by members of one taxon only, although not all members need exhibit it. Complete constancy implies that all the members of a taxon possess the feature; complete constancy is not mandatory, as long as members possess most attributes. Often in practice the features used at lower levels in the classificatory hierarchy are more obvious than those at upper levels.

Lamark (1744 - 1829) first upheld the theory that all taxa have arisen by evolution and are a phylogenetic continuum; taxa, then are merely arbitrary subdivisions of the continuum (Simpson, 1961). A system which is basically a continuum becomes discontinuous in its present time stratum. Although exclusion of the time factor may facilitate classification of ecological data, diurnal, seasonal, and longer term changes are often of salience, and should be incorporated into the scheme if possible. Whittaker developed the continuum theory (1970, 1972), incorporating niche differentiation along an environmental gradient. He proposed ordination of data, rather than delineation of groups; prior to ordination, entities (*e.g.* taxa, or sites) are assigned to positions in a multidimensional space defined by their properties or some measure of their dissimilarity. The relationships between the entities are then expressed in fewer dimensions than those originally considered. In this way ordination may or may not lead to the recognition of groups within a series of sites or taxa.

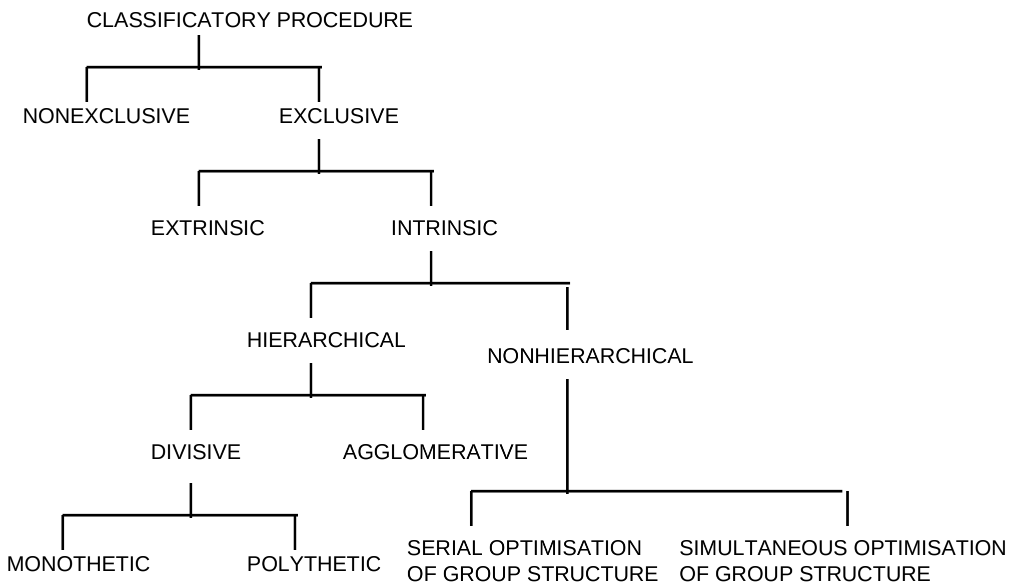

Figure 1: The relationship between classificatory procedures expressed in the form of a dichotomous key (redrawn from Clifford and Stephenson, 1975)

Williams (1971) used a dichotomous key to classification (Figure 1), choosing initially between overlapping/non-exclusive (*i.e.* an entity may appear in more than one group) or non-overlapping/exclusive. Non-overlapping classifications are then subdivided into extrinsic (not well developed) and intrinsic (used to derive groups solely from their attributes). Intrinsic groups, after classification may be examined to determine if they reflect extrinsic discontinuities (particularly applicable to ecological classifications). Intrinsic classifications are subdivided into non-hierarchical and hierarchical. Hierarchical non-overlapping classification produces groups ("clusters"), which do not necessarily exhibit the same homogeneity, and whose relationships to one another are readily expressed in two dimensions. In contrast, non-hierarchical methods can produce clusters of defined heterogeneity but do not link them together in any systematic framework.

Use of hierarchies in folk taxonomy

Ethnobiology refers to the conceptualisation and classification of plants and animals, and knowledge and belief concerning biological processes (Bulmer, 1974). Analysis of folk botanical and zoological nomenclature has shown that organisms are classified primarily on the basis of perceptual similarities as opposed to cultural utility. Most of these ethnobiological classification systems consist of 3-6 taxonomic levels, each with comparable degrees of biological differentiation (Berlin, 1978; Witkowski and Brown, 1978). Within these folk categories, or ethno-biological classes (see Table 1), names fall into one of two linguistic categories. Primary names are "semantically unitary" and are usually simple labels, e.g. eagle, hawk. Complex primary names have more than one constituent but function in language as a simple name. These may be either productive, where the higher category is named (*e.g.* crabgrass), or unproductive, where the higher category is not named (*e.g.* redwood). Secondary names are "semantically binary" and are formed from primary names by the addition of a descriptive modifier. Secondary names exist in contrast sets with similar names, *e.g.* bald eagle, golden eagle (Martin, 1995).

Table 1. Relationship between folk categorisation and nomenclature. Redrawn from Martin (1995).

RANK OF FOLK BOTANICAL CATEGORIES	TYPE OF NAME	NUMBER OF MEMBERS IN ONE SYSTEM
Kingdom	Often unnamed	1
Lifeform	Primary	5-10
Intermediate	Often unnamed	-
Generic	Primary	300-600
Specific	Usually secondary	Typically 20% of generics
Varietal	Secondary	Relatively few

Research has shown that it is plants which need to be referred to frequently which are assigned vernacular (local) names. These names naturally vary from one place, language and people to another, often resulting in multiplicity of names for the same plant, especially those which are widely distributed and economically important (Jain, 1987). Lexical variation may be due to differences in dialect, or simple phonological form (names applied to particular species), or use of synonyms (lexical variants: when distinct or partially distinct lexical expressions are employed to designate the same ethnobiological category), or polysemous terms (refer to more than one object or concept). If these different names are variations of the same word and refer to the same object, they are described as being cognate. Factors relating to the attributed cultural importance of particular plant and animal species will work towards the reduction of linguistic variation for highly important organisms, including their tendency to be labelled by cognate names and *vice versa*.

Although there exists an internationally accepted system of botanical nomenclature, with one name per plant, use of such names is usually confined to research, teaching and scientific literature. In common and local literature, vernacular names are largely employed. These names are usually simple and easy for local people to pronounce (Jain, 1987) and often reveal information about the appearance, utility or distribution of the plant (Martin, 1995; Jain, 1963).

Each hierarchical level within a taxonomy is known as a contrast set. The plant kingdom is implicitly recognised by local people; this unitary taxa contains all higher plants and may include mosses, lichens *etc*. The next hierarchical taxa is that of lifeforms. There are usually several of these broad, distinctive classes, and they are recognised by their utility, habitat, and distribution in a specific ecological zone. Intermediates lie between lifeforms and generics in the hierarchy. These are the most important categories, and consist of small groupings (segregates) of several generics which share at least one semantic feature. These covert categories are often unnamed and may not be recognised by the entire community. The Comaltepec people of the northern sierra of Oaxaca (Mexico) divide the oak tree genus into several named folk generics. Although most Chinantec-speakers realise that all oaks belong to a single class of trees, they do not give a name to the overall category. Generics comprise the most numerous and salient categories, distinguished by their cultural significance. They are easy to recognise, each forming a morphologically distinct unit. Although most generics are affiliated to a lifeform, some morphologically distinct or economically important plants may be independent. Generally about 20% of generics are further divided into specific categories (usually 2-10 per generic), distinguished by colour, geographical location, period of time to maturity etc. Very few specifics are further divided into varietals; those that do are usually of agricultural or cultural significance. Varietals may differ in morphological characteristics, or in their utility or microclimate within the community (Martin, 1995).

In addition to those categories described in Table 1, there are often additional plant categories which do not fit into the general system of folk classification, and often include plants from several lifeforms. These cross-cutting categories are delimited primarily by use, (*e.g.* fruit, firewood, edible greens, medicinal plant), but may be based on other criteria. Various ethnic groups in Mexico classify plants according to their humoral effect on the human body; the metaphorical 'hot', 'cold' or 'neutral' qualities associated with food and medicinal substances (Whiteford, 1995). Farmers in the Eastern hills of Nepal classify trees according to various characteristics (Thapa, 1994):

1. **the effects of the trees on the soil (*rukho-malilo*)**
   - *rukho* trees are those that depress soil fertility
   - *malilo* trees are those that improve soil fertility

2. **fodder quality (*posilo-kam posilo* and *chiso-obano*)**
   - *posilo* fodders are nutritious (high nutritive value)
   - *kam posilo* fodders are less nutritious (low nutritive value)
   - *chiso* fodders (literally cold and wet) are less palatable, often causing diarrhoea when fed during cold months
   - *obano* fodders (literally warm and dry) are eaten voraciously, often causing constipation if fed in excess

3. **fuelwood quality (*kharo*)**
   - the wood of *kharo* trees burns fiercely and produces a lot of heat.

Many knowledge systems and folk taxonomies pertain to local environmental conditions, with segregates describing land-type, landscape, crops and other natural resources based on functional criteria related to utility (Rajasekaran and Warren, 1995). Rice farmers in Chengalputta district of Tamil Nadu state, southern India have classified rice varieties using a hierarchical arrangement of folk categories based on class inclusion, the most inclusive category being the domain, in this case 'rice'. All terms within such a domain have in common a minimum of one semantic feature which differentiates them from terms in other domains (Rajasekaran and Warren, 1995). Categories are segregated according to water source, cropping season, length of maturation period and time of sowing (see Figure 2 and Table 2). Farmers' knowledge of weather, climate and which category a crop variety lies in are all involved in the selection process, along with factors such as production costs, risk, market demand for surplus and cropping pattern.

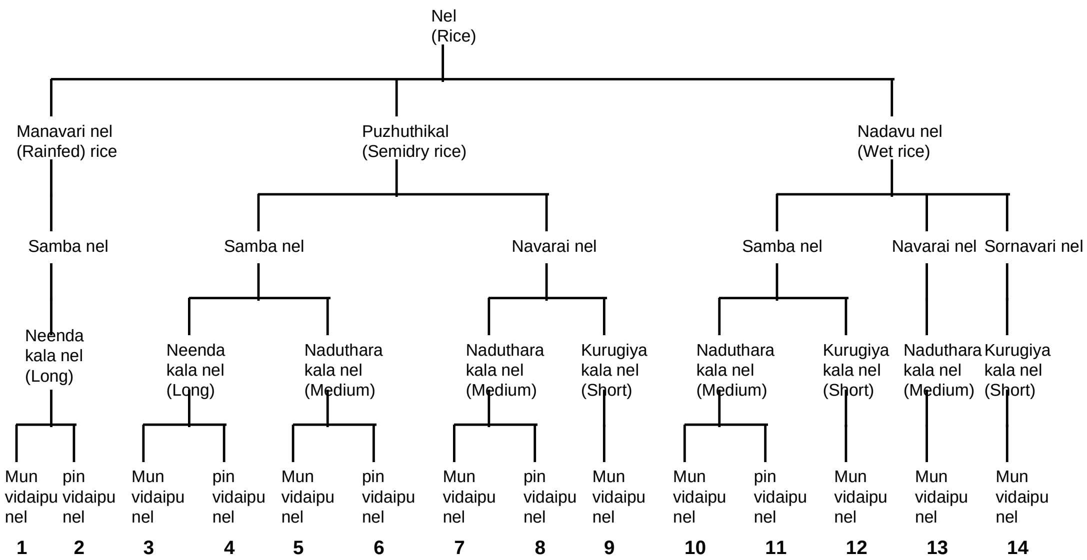

Figure 2: Taxonomy of rice varieties in Tamil Nadu (redrawn from Rajasekaran and Warren, 1995)

This taxonomy is similar to the native Andean classification of potato varieties (Brush 1980), which is characterised by a four-tiered taxonomic system (see Figure 3). The highest hierarchical level, named *papa* throughout the Andes, is classified by Brush (1980) as a folk genus, and contains all tuber-bearing Solanum species. Brush focused his study on the Huancas Quechua speakers in the Mantaro region of Central Peru. These people have a regional dialect, in which *papa* is known by the synonym *akshu*. They recognise four categories within the *akshu* genus, segregated according to cultivation, edibility, processing and frost resistance. Two of these folk species *akshu* and *shiri-akshu* are divided into varieties according to tuber characteristics (see Table 3). The names given to these cultivars are generally descriptive (*e.g. luntush*: "yellow"), but may be analogical (e.g. *calhuay*: "weavers nose"). At this level, Andean farmers also recognise two broad categories: native varieties (referred to as *papas de regalo*: "gift potatoes", or *papas de color*: "coloured potatoes"), and improved varieties (*papas mejordadas*: "improved potatoes" or *papas blancas*: "white potatoes") introduced by the Peruvian National Potato Program. Improved varieties, like their native counterparts, are segregated according to tuber characteristics.

Table 2. Classification of rice varieties by farmers in Chenglaputta district of Tamil Nadu state, southern India. Redrawn from Rajasekaran and Warren (1995).

FACTOR	FOLK CLASSIFICATION	RICE VARIETIES
WATER SOURCE	*manavari nel* (rainfed rice)	suitable for cultivation under rainfed conditions

	puzuthikal nel (semi-dry rice)	grown initially using moisture available from the rain, and later canal irrigated
	nadavu nel (wetland rice)	grown completely under irrigation
CROPPING SEASON	*samba nel*	grown between *puratasi masam* (sept-oct) and *thai masam* (jan-feb)
	navarai nel	grown between *masi masam* (feb-mar) and *vaigasi masam* (may-jun)
	sornavari nel	grown between *vaigasi masam* (may-jun) and *adi masam* (july-aug)
CROP DURATION	*neendakala nel* (long duration)	reach maturity within 145-160 days
	nadutharakala nel (medium duration)	reach maturity within 125-140 days
	kurugiyakala nel (short duration)	reach maturity within 105-120 days
TIME OF SOWING	*mun vidaipu nel*	early sowing rice
	pin vidaipu nel	late sowing rice

Table 3. Classification of potato varieties by Andean farmers. Redrawn from Brush (1980).

FOLK SPECIES	CULTIVATION	EDIBILITY / PROCESSING	FROST RESISTANCE
akshu	cultivated table potatoes	edible after steaming	little or no frost resistance
shiri-akshu	cultivated bitter potatoes	must be processed by freeze-drying to remove glykoalkaloids before eating	frost resistance
kuaro-akshu	semi-domesticated (uncultivated) potatoes found in mid-altitude maize fields	edible - no processing other than steaming required	not frost resistant
atogpa-akshu	wild potatoes	inedible	some frost resistance

Figure 3: Schematic diagram of the Folk Taxonomy of Potatoes in the Mantaro region of Peru (redrawn from Brush, 1980)

Twenty percent of native folk varieties are further divided into folk sub-varieties, corresponding to a native recognition of polymorphism within certain varieties (Brush, 1980). This final categorisation is, however, not widely recognised. This folk taxonomic system is culturally consistent over large regions and occupies a central role in the selection of different varieties of potato. The first type of selection is that between edible (*akshu*) and bitter (*shiri*) potatoes, on the basis of frost resistance.

Selection also occurs within the category of native, edible potatoes, for preferred characteristics, and between native and improved varieties, for culinary status (native varieties are superior) and yield (improved varieties are superior).

Berlin (1973) has shown that fundamental folk taxa are frequently close to scientific taxonomy (see Table 4). Generic and subgeneric taxa often correspond to scientific species, groups of species or genus. The four segregates at the folk species level differentiated by Andean farmers are clearly related to botanical species divisions (Brush, 1980). Folk generic categories often show an equal 1:1 correspondence with a scientific species. Culturally important plants are often split into many distinct categories by local people, i.e. they are over-differentiated. In contrast, plants which are unimportant culturally and not so morphologically distinctive are usually under-differentiated, and may be given polysemic names (i.e. names which refer to more than one object or concept) (Martin, 1995). Berlin recognised two types of under-differentiation; when a generic refers to more than one species of the same genus (type 1), or more than one scientific genus (type 2) .

Table 4. Correspondence of Tzeltal plant generics to local botanical species. Redrawn from Berlin *et al* (1974).

TYPE OF CORRESPONDENCE	PERCENTAGE OF GENERICS
1:1	61
Under-differentiation, type 1	21
Under-differentiation, type 2	14
Over-differentiation	4

Conventions used to display data about ethnobiological classification

Formulating an ethnobiological description requires these initial steps:

- determine the intentional meanings of a set of concepts, most of which are realised by names in a given language, as can be inferred from the ways these terms are applied to a set of living organism

- to discover the structure(s) that unite these concepts into a classificatory system.

- determine the several types of mapping relationship that hold between folk and scientific classification systems. The scientific system may serve as an etic grid, rather than as simply a convenient language for glossing exotic (names for plants and animals) [Hunn 1977]

Berlin (1992) in his review of the conventions used to display data about ethnobiological classification discovered that changes in these conventions reflect advances in the theoretical understanding of principles underlying human categorisation. Conklin (1962) and Frake (1961, 1962) described semantic properties of hierarchically ordered categories ("segregates") using a set of diagrammatic conventions, one of which was the "box diagram" (Figure 4). However, Kay (1971) criticised this approach, describing box diagrams as being visually ambiguous (Figure 5: wild pepper 'on a level' with both houseyard pepper and houseyard chilli pepper), and instead proposed the use of "tree diagrams" to display the semantic structure of a domain. Formalization in this more precise way led to the general adoption of tree diagrams in many subsequent studies.

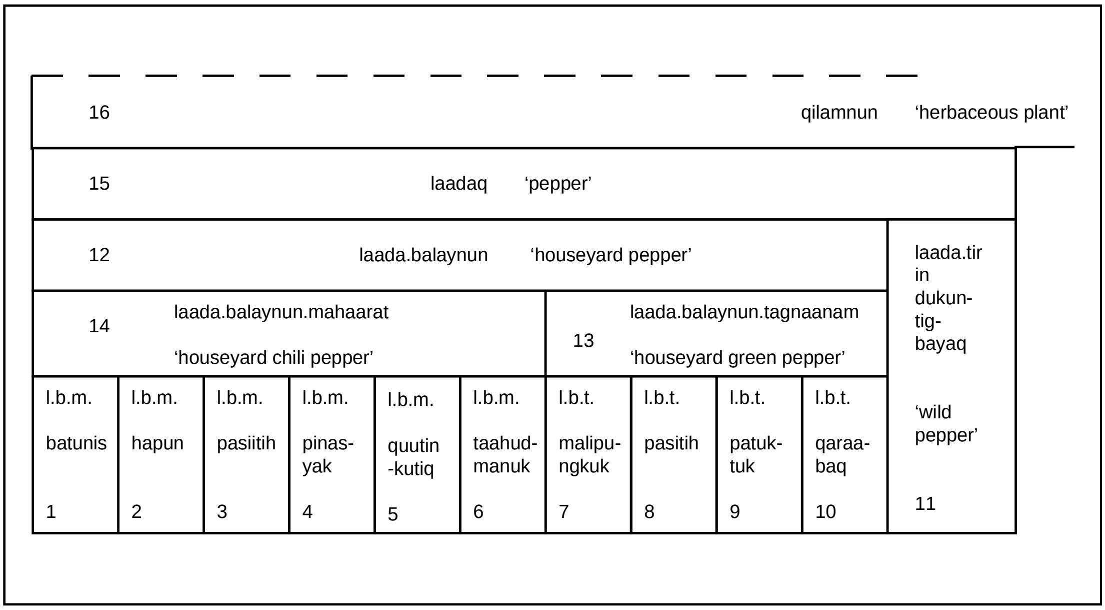

Figure 4: A fragment of Hanunoo classification of peppers (*Capsicum* spp.), as shown by the use of conventional box diagram (redrawn from Berlin, 1992)

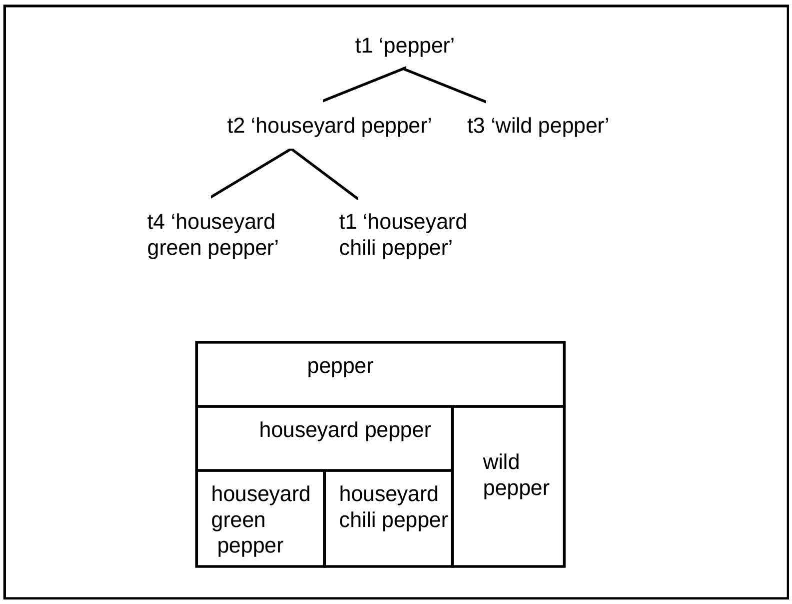

Figure 5: Comparison of diagrammatic representation of the semantic structure of a fragment of Hanunoo classification of peppers using a tree diagram (top part of figure) and box diagram (bottom part of figure) (redrawn from Berlin, 1992)

Several inadequacies in the taxonomic model, however, led to dispute over whether a taxonomic hierarchy was relevant at all. Bright and Bright (1965) studying the influence of language on thought among American Indians in California, found that taxonomic structures were less hierarchically organised than our own with relatively few higher order terms, and many terms not falling into any hierarchy. They criticised the hierarchical model for showing only the relationship of domination (*i.e.* an item either is or is not a member of the class named by the higher node); this does not account for the occurrence in Indian taxonomies of a semantic association between two taxa joined in a relation of immediate precedence where the two taxa are labelled by the same polysemous term, *e.g.* the use of the Yurok term *tepo* as both lifeform (tree, *i.e.* includes other coniferous trees) and generic (fir). In addition, hierarchically structured models include no conventions for dealing with descriptively named taxa that were treated as outliers of habitually labelled ethnobiological categories; when informants were asked to identify a plant which had no name, they would respond that the species in question was 'like' another plant, more central to the focus of the domain, rather than assigning it to a named class. Bright and Bright (*ibid.*) attempted the use of Venn diagrammatic conventions to represent the "sphere of influence", but succeeded only in obscuring the underlying semantic structure.

In 1969, Berlin and Kay proposed that semantic categories can be more accurately characterised as having an internal structure, with some members being thought of as being more central (*core*) than others (*peripheral*) (renamed as italics by Hunn 1976), Berlin *et al* (1974) described ethnobiological taxa as showing basic and extended ranges in their referential meaning, *i.e.* taxa possess unambiguous foci (genuine referents) which shade into ambiguous boundaries, where extended ranges overlap. Berlin *et al* (1974) found hierarchically structured tree diagrams unsuitable for representing focus and overlap, and they too explored the use of Venn diagrammatic conventions unsuccessfully.

Gardner (1976) and Ellen (1979) both experimented with Venn diagrammatic conventions, the latter producing classification systems in an explicit, concise and easily understood manner (Figure 6).

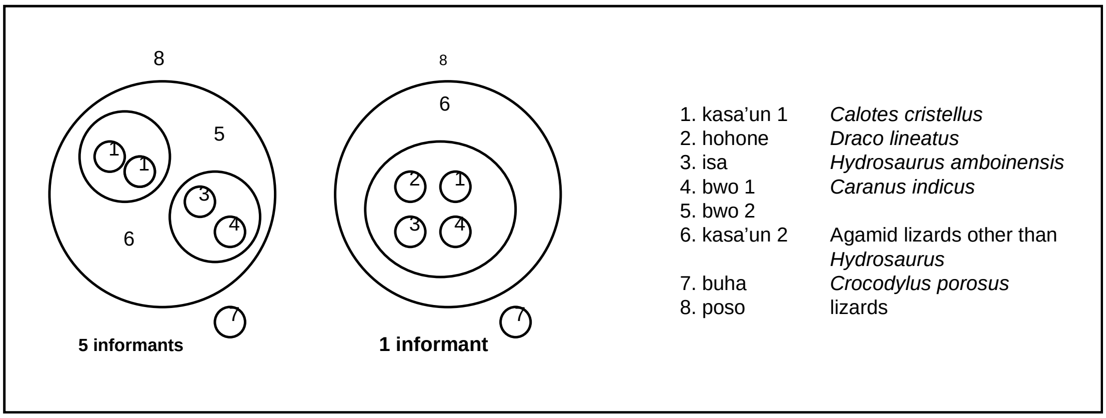

Figure 6: Nuaulu classification of lizards presented in the form of Venn diagram, indicating two variant systems of classification (redrawn from Berlin, 1992)

Jensen (1988), combined the use of tree diagrams with a "rings of Saturn" model, depicting the prototypical category of a group of related taxa as the central member, surrounded by taxa of varying degrees of similarity to the prototype - those closest to the centre the most similar (Figure 7).

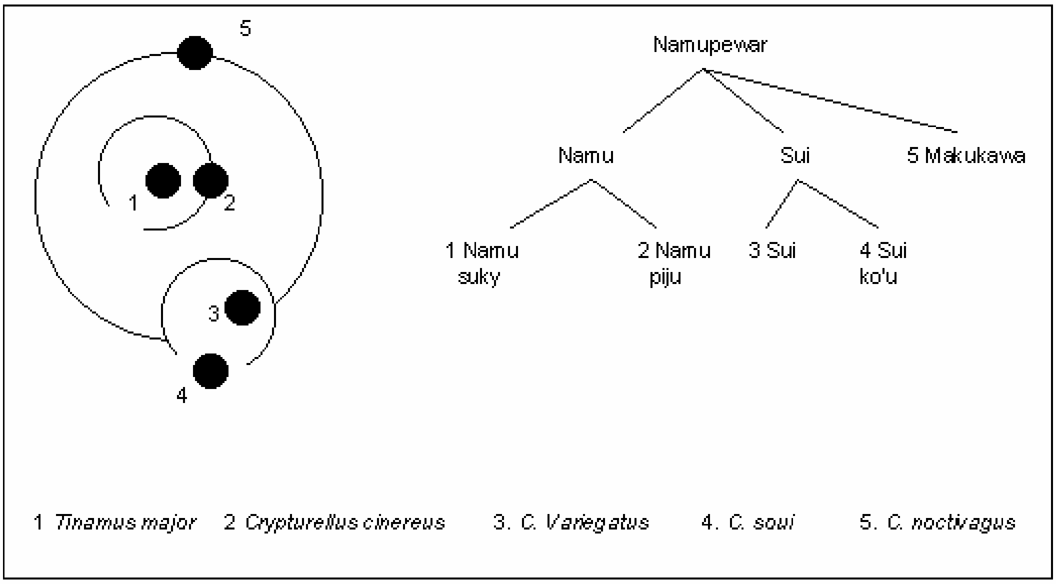

Figure 7: Diagrammatic representation of Wayampi classification of tinamous, combining branching tree diagram as well as "rings of Saturn" model of presentation (redrawn from Berlin, 1992)

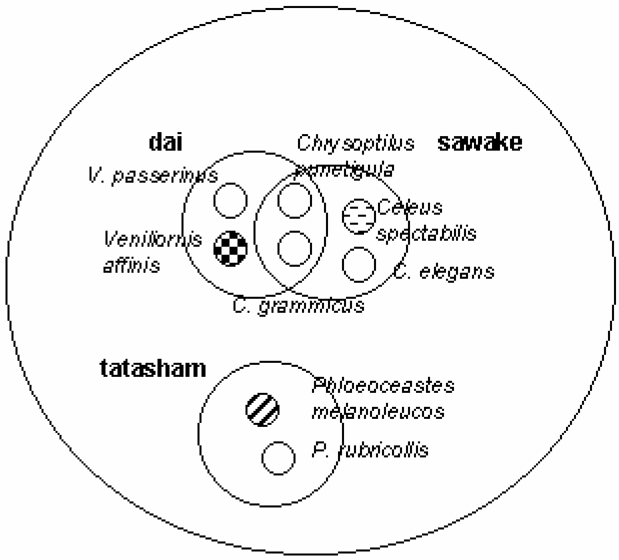

Figure 8: Classification of Aguaruna woodpeckers. Diagrammatic conventions are explained in the text (redrawn from Berlin, 1992)

Finally, Berlin (1992) used a further method of modifying Venn diagrams to represent his data (Figure 8).Conventions used are:

- Circles within circles indicate class inclusion
- Overlapping circles indicate class intersection
- *Biological taxa* are outlined as small solid circles always of the same size. Unless otherwise stated, these taxa will represent biological species.
- *Ethnobiological taxa* are indicated as faint grey circles that encompass one or more biological species. Ethnobiological taxa so represented may be of any rank, unless indicated.

- *Prototypical* members of ethnobiological taxa are indicated by distinctive hatching of the relevant biological species.

- The *relative perceived similarity* of ethnobiological taxa is indicated by the relative distance by which they are separated from one another in each diagram.

- Names of *ethnobiological* and *biological taxa* are given in ***bold*** and *standard italics* respectively.

This diagrammatic form allows representation of covert categories, here the most inclusive taxon: 'woodpeckers'. However 'outlying species' must be represented with different conventions (Figure 9); relative distance from central species indicates strength of affinity to that central species. Berlin's diagrammatic method enables the explicit indication of biological and ethnobiological taxa by means of circles drawn with contrasting boundaries. Thus it is possible to discuss the biological ranges of folk taxa somewhat more clearly than when no distinction is made. In addition, attention is immediately drawn to the prototypical members of folk taxa (marked hatching), and overlapping membership of particular folk taxa is readily observed, leading to rapid inferences of affinity between taxa via the species that form the intersection of two or more categories.

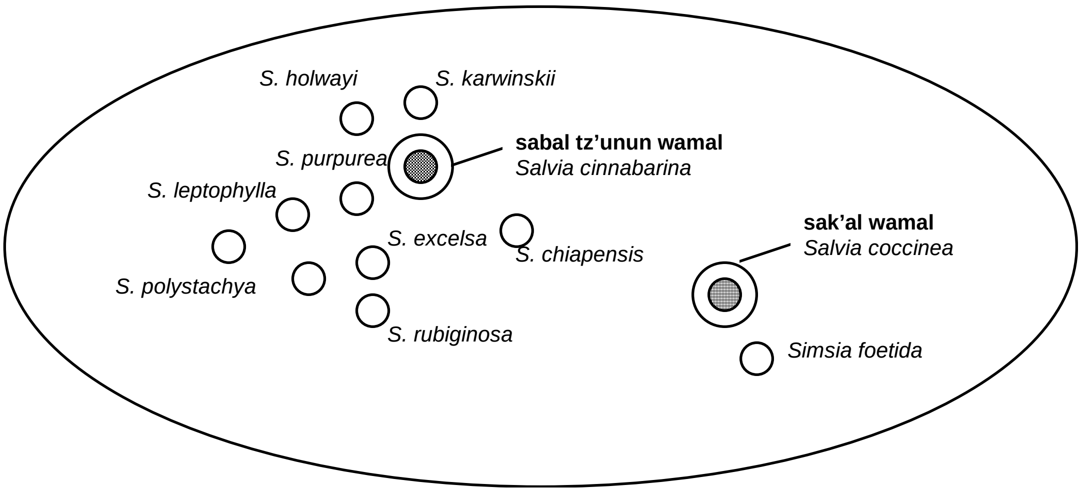

Figure 9: Schematic representation of the classification of locally occurring species of *Salvia* and one species of *Simsia* by the Tenejapa Tzeltal (Mexico) illustrating diagrammatic conventions used in Berlin's present work (redrawn from Berlin, 1992)

Use of hierarchies in the representation of indigenous knowledge

Hierarchical structuring of knowledge bases allows knowledge to be recorded at its most generic level of application, whilst still considering more specific instances, through consideration of hierarchical linkages between terms (Walker, 1994). If, for example, 'wheat', 'barley' and 'maize' are identified as annual crops within a hierarchy, information that annual crops only live for one year can be recorded at this level rather than for each individual crop (Walker, 1994). It can be seen from Tables 5.1 and 5.2 that capturing information in this implicit way helps increase the parsimony of the knowledge base.

Table 5.1. A complete set of unitary statements. Redrawn from Walker *et al* (1994)

Crops are economically useful	Legumes photosynthesise
Legumes are economically useful	Chick peas photosynthesis
Root crops are economically useful	Pigeon peas photosynthesis
Cereals are economically useful	Cowpeas photosynthesis
Chick peas are economically useful	Legumes have roots
Pigeon peas are economically useful	Chick peas have roots
Cow peas are economically useful	Pigeon peas have roots
Crops are deliberately cultivated	Cowpeas have roots
Legumes are deliberately cultivated	Legumes have leaves
Root crops are deliberately cultivated	Chick peas have leaves
Cereals are deliberately cultivated	Pigeon peas have leaves
Chick peas are deliberately cultivated	Cowpeas have leaves
Pigeon peas are deliberately cultivated	Legumes transpire
Cow peas are deliberately cultivated	Chick peas transpire
Crops are plants	Pigeon peas transpire
Legumes are plants	Cowpeas transpire
Root crops are plants	Legumes are crops
Cereals are plants	Root crops are crops
Chick peas are plants	Cereals are crops
Pigeon peas are plants	Chick peas are legumes
Cow peas are plants	Pigeon peas are legumes
	Cowpeas are legumes

Table 5.2. A compacted statement of the knowledge in Table 5.1 based on a hierarchical structuring. Redrawn from Walker *et al* (1994)

Crops are deliberately planted	Legumes are crops
Crops are plants	Root crops are crops
Legumes photosynthesise	Cereals are crops
Legumes have roots	Chick peas are legumes
Legumes have leaves	Pigeon peas are legumes
Legumes transpire	Cowpeas are legumes

Hierarchies are also employed in expert systems such as IKS EXPERT, which incorporates the classification of rice varieties in Tamil Nadu, India (discussed above) in the process of matching crop varieties to locations (Babu *et al*, 1995). Evaluations are based on resource availability (irrigation), cropping season and final use (Figure 10).

The utility of hierarchically structured systems such as those described by Walker (1994) and Babu *et al* (1995) can be compared with different approaches to knowledge representation. Johnson (1980) formulated a cognitive paradigm of the various land types involved in slash-and-burn agriculture in N.E. Brazil, first eliciting a basic corpus of terms describing land typology (Table 6), and from these, deriving a reduced set of stable, mutually contrasting concepts (Table 7). By investigating the dimensions of contrast differentiating these terms, Johnson elicited amongst others, two dimensions of contrast used with high frequency by consultants, and therefore assumed to be of cognitive salience in the community. The first dimension is that of "fertility", measured by an ordinal scale between polar opposites represented by *forte* ("strong"), and *farce* ("weak"). The second dimension is that of "moisture", taken by Johnson to be dichotomous; land is classified as either dry ("hot") or wet ("cold"), represented by *quente* and *frio* respectively.

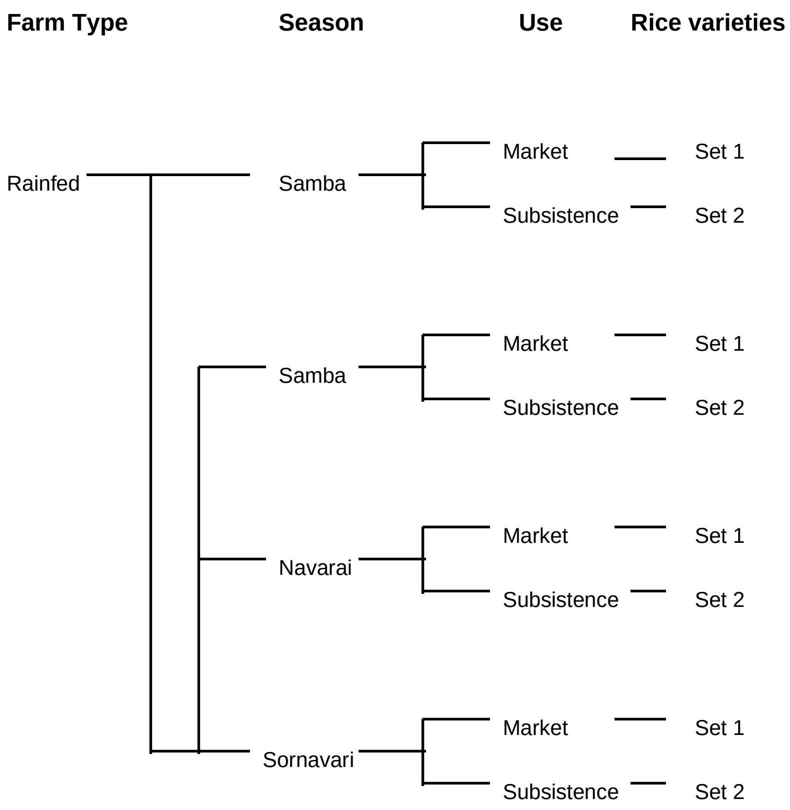

Figure 10: Decision tree for crop varietal selection for farming systems research based on Indigenous Knowledge Systems (Redrawn from Rajasekaran and Warren, 1995)

Table 6.1. The basic corpus of terms describing land typology in slash-and- burn agriculture in N.E. Brazil. Redrawn from Johnson (1980).

TERMS DESCRIBING LAND TYPOLOGY	TRANSLATION
rocado novo	1st year swidden
capoeira	2nd year swidden
capoeira velha	"old swidden" (3rd year)
campestre	sandy hillside
coroa	river margin
rio	river bottom in dry season
lagoa	lake
baixo	lowland
brejo	swamp
vasante	margin of reservoir
lastro	single crop field
quintal	backyard
corgo	river margin
salgada	saline
satio	irrigated land

Table 6.2. Terms which overlap with other terms. Redrawn from Johnson (1980).

TERMS	TRANSLATION
corgo	river margin
quintal	backyard
lastro	single-crop field
satio	irrigated land

campo	field in which tree stumps have been removed for planting

Table 6.3. Terms which together form one concept, that of low-lying, moist lands of poor drainage in contrast with others. Redrawn from Johnson (1980).

TERMS	TRANSLATION
lagoa	lakes
baixo	lowland
brejo	swamp
vasante	margin of reservoir

Table 7. Set of stable, mutually contrasting concepts. Redrawn from Johnson (1980).

rocado novo	*coroa*
capoeira	*rio*
capoeira velha	*lagoa, baixo, etc.* (no cover term)
campestre	*salgada*

The land type paradigm thus created (Figure 11) contained no information beyond these two dimensions, and Johnson (*ibid.*) appreciated that a more extensive cognitive analysis would be required to illustrate the much finer distinction between particular plots (or parts of plots). Representing additional dimensions (such as soil pest prevalence, aspect of fields relative to the sun and wind, number of years fallow prior to clearing) would necessitate a complex multidimensional model.

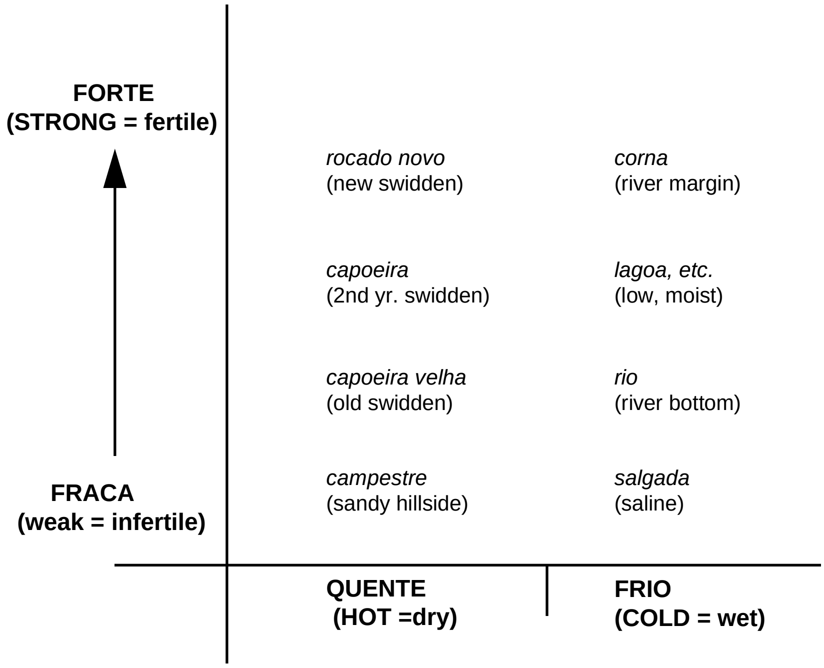

Figure 11: Land types (redrawn from Johnson, 1980)

Elicitation of such a detailed understanding would be difficult, and may often reflect individual skill, as opposed to shared cultural information. Cultivation techniques and patterns of low energy societies such as Brazilian slash-and-burn farmers and Andean potato farmers (discussed earlier) are characterised by their adaptability to the particular conditions of their environment (Brush 1977). This relationship between cultural traits and natural conditions was perhaps first observed by Wissler

(1926).Vayda and Rappaport (1968) have proposed that adjustment of traits to conditions is based on the principle of homeostasis: "human manipulation of local environments to meet human needs without causing serious environmental perturbation or degradation - allowing them to maintain a standard of living in spite of their limited ability to manipulate and alter the environment". Hence it is not only an individuals' skill which dictates his practice, but also the quality and geographical location of his land. This is discussed with relevance to the problems Johnson (*ibid.*) encountered when he used his cognitive paradigm to predict actual planting behaviour.

Johnson established that over 90% of all produce raised on the plantation is grown in four types of fields: *rocado novo* (1st year swidden), *capoeira* (2nd year swidden), *coroa* (river margin) and *lagoa* (low, wet land). His model predicts that squash (stated by consultants to "prefer" strong, hot soils) will grow best in rocado novo, and this was verified by the observation that most squash plants were found in 1st year swiddens. However, in other cases the utility of the model is restricted. Two varieties of manioc are grown, manioc *manipeda* and manioc *carredageir*a. Manioc *manipeda* "prefers" strong, cold soils (confirmed by the model), whereas manioc *carredageira* "prefers" hot soils and is more tolerant of weaker soils. However the cognitive paradigm shows that not all manioc *carredageira* is grown in hot soils, and most is grown in weak soils. This is because manioc grows best in single crop fields (*lastro*); as *rocado nova* is typically planted with a variety of crops, more hot-land manioc is planted in 2nd year swiddens than in first year swiddens, representing a trade-off between fertility and competition.

Such trade-offs cannot be represented on any model, because they are by nature idiosyncratic; they occur as a result of a decision made by each individual farmer, and each farmer may have different priorities and opinions. A classic example of such an occurrence is the planting of cold-land beans (*de moita*) by one tenant in a hot-land plot near to the house. Cold-land beans yield sooner than hot-land beans (*de corda*) and are therefore an important food source early in the planting season. Although this particular tenant possessed a cold-land plot on the other side of the river, ripening of the early beans occurred at the same time of year as the onset of seasonal floods, rendering the cold-land plot inaccessible. Hence categorisation of the moisture dimension, is more of a process-based knowledge system than a classification system.

Conclusion

This review has presented on overview of folk classification and nomenclature, and conventions used in representation. The importance of knowledge of the individual, with respect to the greater shared knowledge of the community as whole, has been discussed. Werner (1969) has stated that culture may be viewed as the common element which all members share, *i.e.* the set theoretical INTERSECTION of individual competences. In ethnographic ethnoscience, however, as in traditional lexicography, the complementary view is taken: the description is an attempt to characterise the set theoretical UNION of all individual competences. The latter view presents the notion of an "omniscient informant" (Hays 1976), but does not indicate how best to characterise the set theoretic union of the knowledge of all. Some knowledge is more important, in that it is more salient and widely shared, while some is idiosyncratic and unique to the individual. In addition to the different opinions and priorities which may be held by individual farmers, D'Andrade (1970) has shown that the amount of shared knowledge in close-knit communities rarely exceeds 60%, thus many mentally shared rules remain unique to the individual. Hence any shared cognitive paradigm will predict only some of the variation in a distribution of actual outcomes (Johnson, 1980).

Cognitive variation deals with the differential distribution of ethnobiological knowledge as it relates to different ways of classifying the same things. People in traditional societies are likely to vary in what they know about plants and animals as a function of their gender, age, or social status. In addition, knowledge actually communicated may be contextual. Bulmer (1969) found that his informants geared their responses to what they estimate to be the level of the field worker's sophistication, and Boster (1980) found that Aguaruna women are unlikely to offer specific names for manioc in response to questions from men since they know that males only know the generic term. Hence in strongly patrilineal societies, knowledge of the female members of the community may well have been seriously underestimated.

But can knowledge, both shared and idiosyncratic be represented hierarchically? And if so, how can conditionality be incorporated? Imposing a hierarchical structure on a set of knowledge necessitates strict categorisation of knowledge, often to one of two polar opposites. Thapa (1994) got around this problem by having an intermediate, but there will always be various scales of intermediacy. If distributional patterns are completely continuous, it becomes impossible to delineate groups; in this situation it may be better to represent knowledge by ordination.

The alternative to hierarchical representation is representing knowledge as a series of single unitary statements (Walker *et al*, 1994). Although this very basic methodology allows the representation of conditionality within the statement, it has the disadvantage of inefficiency of storage and divorcing the statement of knowledge from the context in which it is applied. It has been seen that categorisation of knowledge is often context-dependant, especially if the time factor is included; Nepalese farmers recognise that fodder quality often varies throughout the year, hence categorisation will change accordingly, and trees may appear in more than one group. Berlin's model (Figure 8) enables such overlapping groups to be represented, but the only way overlap and conditionality can be represented hierarchically is by having multiple hierarchies. Hence the two-dimensional model becomes multi-dimensional and the simplicity inherent in hierarchical representation is lost. To conclude then, although hierarchies retain their fundamental utility in terms of structuring and ordering a body of knowledge, they do not possess the flexibility to cope with the intricacies of a continuously interacting and evolving world.