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Ethnotaxonomic systems can reflect the vitality status of indigenous languages and traditional knowledge

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Biodiversity rich regions of the world are also known to harbour rich ethnic, cultural and linguistic diversities. Traditional Knowledge (TK) of indigenous communities could be one reason behind this factor as it facilitates ecosystem management and agriculture. TK is dependent on languages, without which, its transmission and accumulation is impossible. In this paper, it is argued that the ethnotaxonomic system of an indigenous community is an interjunction between its language and traditional knowledge. Both language and traditional knowledge are required to generate lexemes that are the building blocks of any classification system. TK generates scientific information related to ecology, morphology or utility of the life form while the language names it, and transmits information related to it across individuals and generations; Language gives the name while TK connects it to the appropriate denotatum. We argue that the vitality status of the community's indigenous language and TK is reflected in its ethnotaxonomic system. We also present a newly developed Traditional Knowledge and Language Vitality index (TraLaVi) which could complement the existing indices which intend to assess the vitality status of indigenous languages and TK.

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It is now known that areas of high linguistic diversity also harbour rich biological diversity; of the more than 6,900 languages spoken on earth, more than 4,800 occur in regions of high biodiversity[1,2]. Although the causal mechanism behind this co-occurrence is not clear, it can be said that the factors affecting biological diversity could also affect linguistic diversity. Since 1990, different researchers have attempted to uncover the relationship between languages and biodiversity, which has led to the development of several theories that have approached this issue from anthropological, linguistic and biological angles.

Co-occurrence of linguistic and biological diversity

Linguistic diversity is known to be influenced by environmental, socio-cultural and spatial heterogeneity variables[3]. The distribution of lineage density of languages is affected by geographical and economic factors that determine the availability of resources and their distribution[4]. Factors such as availability of resources, climatic variability, physical isolation, habitat heterogeneity and history that are responsible for species richness may also influence the generation and maintenance of language richness[4,5]. Both linguistic and biological diversity increase as we move towards the equatorial regions and decrease towards the poles. Tropical climate permits year round food production offering self-sustainability to small communities, while temperate zones with distinct seasons restrict year round food production, resulting in the expansion of the social network of communities which in turn leads to the wide spreading of languages[6]. Contrarily, Sutherland[1] finds little evidence to support this theory. Political complexity and subsistence strategies of societies are also hypothesized to influence the expanse of languages[7]. For instance, languages of foraging societies facilitate the development of tools with greater precision to utilise natural resources, especially to produce and acquire food[7-9]. Fincher & Thornhill[10] show a strong correlation between linguistic diversity and parasitic diversity. They argue that human societies tend to diverge due to a

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preference for mating and socialising, induced by the 'parasitic wedge'. However, considering the fact that endogamy and cultural and linguistic preferences offer limited cultural scope for exchanging genes with 'outsiders'[11,12], parasitic diversity should have been the result of genetic diversity prevailing in human societies and not vice-versa. Several researches have indicated a strong relationship between linguistic and genetic diversity[13-15]. New evidence suggests a genetic disposition towards languages; mutations affecting certain genes can cause language and speech disorders[16]. The ability to process language and speak them is a cumulative effect of multiple genes and also the environment with which an individual interacts. Genes such as *ASPM* and *Microcephalin* are known to influence an individual's ability to learn tonal languages such as the Chinese[17,18]. The question of whether genetic diversity gives rise to linguistic diversity has not been answered yet. Most theories discussing linguistic and biological diversity cite the availability of resources as one of the reasons for the co-occurrence of these two entities. Available evidence now, points to the undeniable influence of human beings on the global vegetation composition. One pathway of influence could be that the Traditional Knowledge (TK) held by communities has enabled them to manage their ecosystems so as to generate greater biodiversity[19].

How language and TK influence Biodiversity

Human beings have manipulated their ecosystems so as to derive maximum benefits; for example, indigenous areas of Amazon tend to show higher resistance to deforestation and forest fire than uninhabited parks[20]. The present day composition of the tropical forests along the Xingu River of the Amazon is an indigenously 'constructed' one[21]. The Maya of Mesoamerica have managed their ecosystem through a complex maize based agroforestry system and this practice continues today[22]. At the global level, more than 75% of land from the ice-free regions has undergone alteration due to human activities[23]. If biodiversity is higher in regions inhabited by indigenous communities, rather than urbanised zones, then the causal factor is the indigenous land use patterns, which in turn stem from the respective cultures and TK. TK accumulated through years of observation and experimentation is the primary tool that has been used by human beings for the management of their ecosystems[19]. Only a fraction of this TK has been transmitted as codified knowledge, while most has been transmitted orally. Thus, TK is dependent on languages, and the loss of languages might lead to the loss of TK[24]. Use of land and natural resources - both biotic and abiotic, require specialised vocabularies to acquire, communicate and transmit traditional knowledge associated with the resources. Beliefs (taboos, preferences, religion, divination, etc.), calendric systems, agriculture, hunting & foraging, etc. are all TK driven mechanisms that facilitate ecosystem management, while folklores in the form of lullabies, ballads, legends, jokes, riddles, etc. play a major role in transmission of knowledge within as well as between generations.

The relevance of Ethnotaxonomy to language, biodiversity and TK

Language is the most commonly used proxy in assessments of TK vitality, with lexical recollection/recognition being a widely accepted method, both in linguistic as well as TK vitality assessments. Ethnotaxonomy is an interjunction between language and TK. TK provides the scientific structure or mechanism (e.g. ecology, utility, quality, etc) to name biotic and abiotic elements of an ecosystem, while the indigenous language provides the linguistic form, and transmits information related to it across individuals and generations. In other words, language gives the name while TK connects it to the appropriate denotatum. Thus, both TK and languages contribute to the identification, recognition and transmission of knowledge of life forms. Classification systems help human beings to reason with, relate to and interact with the environment, a property also shared with language[25-27]. Human cognition "draws extensively from inductive inference—finding similar patterns, learning grammars, devising theories, creating rules and categories to explain (typically perceptual) data"[28]. Lexical selection is an important part of speech production[29], and also an important part of ethnotaxonomy. When a language disappears, the local name for plants and animals also disappear indicating a corresponding loss of TK that led to the generation of those names. Ethnoclassification systems can be as good as formal systems of classification and the loss of such systems also means that there is a corresponding loss of a cost-effective, locale specific system of biodiversity inventorying[30-31].

Support for the use of ethnotaxonomy to gauge the loss of TK, culture and language comes from two recent studies. Saynes-Vásquez *et al*.[32] used ethnotaxonomy to gauge the impact of cultural change on TK of the Zapotec people of Mexico. They used herbarium specimens and photographs of 30 specimens to elicit information on recognition of species, knowledge of plant forms, generic names, specific names, and local uses. The study of Unasho[33] shows that vocabularies are 'cultural genes' of language and TK, and their loss can be used as indicators of linguistic vitality and stratigraphy, hence agreeing with previous studies[34-36]. Folk names for plants and animals point to the ethnotaxonomical categories (unique beginner, life form, generic, specific, varietal) that are explainable both in linguistic, as well as ethnobiological terms, a dual property well recognised by Berlin *et al*.[37]. All languages classify organisms into taxa using lexemes, and these lexemes are the building blocks of both languages and ethnotaxonomical systems[37,38]. The foundation of TK lies in the ethnotaxonomic system, which aids the community in: 1) Identification of plants and animals, 2) Storing and retrieval of information, and 3) Identifying new elements in the ecosystem and integrating them into a knowledge system[39].The ability to identify, recognise, process and recollect information on natural resources is also a characteristic feature of languages.

Having established that ethnotaxonomic systems are an interface area between indigenous languages and TK, it can be argued that these systems could reflect the health status of both indigenous languages and TK. Using ethnotaxonomy and nomenclature as key indicators, we developed the Traditional Knowledge and Language Vitality index (TraLaVi) in 2013, with the aim to help ethnobiologists generate a quick understanding of the health status of an indigenous language and TK (Tables 1 & 2). The basic structure of TraLaVi was laid out in late 2012 and funding from the Firebird Foundation, U.S.A, was realised in the same year and it took us another year for finalising the structure. Although unintentional, the TraLaVi does bear some resemblance to the Global Index of Ethnobotanical Knowledge (GIEK) developed by Saynes-Vásquez *et al.* [32].

The need for TraLaVi

The concept of Ethnolinguistic Vitality (EV) promotes an understanding of language maintenance and shift[40],which are the primary factors responsible for language erosion and loss. Since language endangerment and its eventual loss is a cumulative effect of many factors, different approaches have been developed to assess EV. UNESCO has been on the forefront in addressing language loss, and has produced an interactive atlas that has proven to be an indispensable tool in understanding language endangerment[41]. Drawing from her 14 yrs of experience while working for SIL international, Landweer[42] developed a set of eight indicators to understand the vitality status of a language. Fishman's Graded Intergenerational Disruption Scale (GIDS)[43] which was later expanded by Lewis and Simons,[44] is another notable tool to gauge Ethnolinguistic Vitality. These works have paved the way for the development of different indices that could aid in assessing the health status of languages: Language Vitality Index[45]; V model[46]; Linguistic Vitality Test [47]; Index of Linguistic Diversity[48], etc. The existence of a diverse range of theories, models and indices contribute to a better understanding of EV[49].

Traditional Knowledge on the other hand, can be assessed by applying numerous indices mostly developed by ethnobiologists: Ethno-phytonymy index[50]; Species Diversity Value[51]; Relative Use (RU)[52]; VITEK[53]; Knowledge Richness Index (KRI) and the Knowledge Sharing Index (KSI)[54]; Utilization Index[55]; Use Value Index UVs[56,57], etc[58-60]. Existing Language indices adopt a macro-scale approach, giving priority to factors affecting entire populations of speakers, whereas TK indices give an ecosystem level understanding, while ignoring the language component. Such approaches do not take into account the relationship between indigenous languages and the ecosystems in which they have evolved. In such a scenario, an index that could give a quick understanding of the language-TK scenario is lacking. We believe that TraLaVi could assist field ethnobiologists by providing a quick assessment of the vitality status of language and TK in an indigenous set up.

The TraLaVi index

TraLaVi uses free-listing to a great extent (Table 1). Free-listing is a quick and efficient interview method to elicit domain specific information[61]related to both language and TK. Free-listing has been used extensively to elucidate ethnotaxonomy of various communities, as well as to test the verbal proficiency

Table 1—The Traditional Knowledge and Language Vitality index

Criteria	Indicator	Rating
A	Free-listing of 25 plants in L2, time taken Free-listing of 25 plants in L1, time taken	25
B	Free-listing of plants (25 names) in L1	25
C	Explaining the meaning of the names of the free-listed native plants in L1	25
D	Identifying common plants in L1 from a given sample of 25	25
E	Have they received/transmitted traditional information on Folklore, Uses (uses of Cultural/Culinary/Medicinal), Beliefs, etc pertaining to the 25 plants from Criteria (D)	25

Note: L1= autochthonous language; L2 = allochthonous Language

Table 2—Reasons for choosing the criteria

Criteria	Reasons
Language priority (Criteria A)	Bilingualisation is sustainable only when the degree of valuation and functions of L2 is lower than L1. If not, there is an inherent danger of the L1 disappearing soon[64]. Comparing the time taken by an individual to recollect names in L1 and L2 could provide a quick evaluation of the priority accorded to L1.
Retrieval of information (Criteria A, B)	Domain specific information is retrieved through free-listing[61].TraLaVi only considers lexemes pertaining to common domains of knowledge such as ‘food plants’.
Knowledge erosion (Criteria C)	Lexemes used as folk plant names are condensed forms of knowledge, and both language and TK are required to interpret the meaning of these lexemes. Mechanisms of TK used in nomenclature include ecology, morphology, utility and quality, while linguistic mechanisms include polysemy, metonymy, synonymy and monosemy[65,66]. It is assumed that participants well versed in both language and TK would be able to interpret names, so as to reveal the linguistic and TK mechanisms.
Lexical recognition (Criteria D)	Visual stimuli have been used successfully by previous researchers to elicit information[67-69]. This criterion not only assesses the ability of an individual in recognising the plants/animals, but also the ability to connect a lexeme to its ‘denotatum’.
Social support for exchange of TK (Criteria E)	This criterion provides us with an understanding of the level of TK exchange happening between individuals. Transmission of information is important for the survival of both TK and languages[70]. While TK acquisition by an individual begins right from early childhood and continues lifelong, intergenerational loss of TK and incomplete transmission among younger generation is increasingly threatening the survival of TK[71]. Individual researchers using TraLaVi could explore possibilities of expanding this criterion so as to address intergenerational and efficacy of TK transmission.

of a respondent. It can demonstrate the respondent’s cognitive preference[62], status of cognitive ability[63], and depth of knowledge[63]. TraLaVi uses both free-listing and lexical recognition to assess language priority, retrieval of information, knowledge erosion, lexical recognition, and social support for exchange of TK (Table 2).

TraLaVi could be used to assess Language and TK vitality in the following scenarios: 1) between generations of people, 2) between populations living in different sites, and 3) between populations that have different linguistic preferences (mono lingual, bilingual, etc.). The assessment involves two phases, as described below.

Phase 1, collection of ethnobiological data

Traditional knowledge is seldom shared equally amongst all individuals of a community. Within the community, TK onmedicinal plants, child healthcare, ritual plants, ethnoastronomical information, etc. might still be held private, but is put into common use by individuals specialising in such individual domains. A shaman would naturally be more knowledgeable than a farmer when it comes to ritual plants. Whereas, the farmer might have a higher degree of knowledge of agrobiodiversity. Thus, it is advisable that the researcher identifies a shared domain of knowledge in the community such as ‘food plants’ and then she/he documents all the plants commonly used as food throughout the community by generating free-lists from the elders (>60 yrs). The names commonly used to identify these plants are to be recorded with phonetic notes and the audio files should be saved. From the exhaustive list produced, the most commonly used 25 plants in the community are shortlisted on the basis of their salience. It should be ensured that there is balance of gender and professions among the sample population so that it is a true representative of people above 60 yrs of age. Much of ‘TraLaVi’s applicability depends on this 'control' data generated. Communities who have already documented their TK and have ranked their species by applying importance indices[61], could use the list as 'control' instead of free-listing.

Phase 2, applying the index

2.1) Participants (e.g. a particular age group or a distinct population) free-list 25 plant names in L2, and the time taken to complete the list is recorded. Although 25 listings have been mentioned as the upper limit, the researcher is free to choose more than 25 depending on the salience and depth of knowledge prevailing in the community. Moreover, the intention of free-listing exercise in this phase is not to generate an exhaustive list of plants used/known to the participant.

2.2) The process is repeated for plant names in L1, and the time taken to complete the list is noted down. Since the purpose of this step is to gauge the relative ability of an individual to retrieve lexemes, the results from steps (i) and (ii) are to be juxtaposed against each other. If L2>L1, it indicates that the participant is more adept in his/her native language and vice versa. If L2=L1, it indicates that the participant is a perfect bilingual without any loss of L1. The scores are L2>L1= 25; L2=L1= 25; L2< L1=15 (complete list in L1); L2<L1= 0 (incomplete list in L1).

2.3) During step 2, if the participant has successfully free-listed 25 plant names in L1, the rating provided is 25 (1/plant name). Depending on the language/TK competency, the list may or may not be complete.

-If the respondent is able to list only five species in L1, then the rating provided is 05.

-If the respondent wrongly lists a lexeme borrowed from another language, then the rating given to that name is '0'. However, if the plant/animal doesn't have any known name in L1, then the rating is positive, i.e. '1'

2.4) The participant is requested to explain the meaning of the L1 names free-listed for the above step (1/successful explanation). However, certain lexemes might not carry any meaning and the participant is provided full rating for such lexemes.

2.5) Participants are requested to identify the photographs or specimens or a combination of both, of the 25 plants identified in phase 1 in L1 (1/successful identification in L1 only).

2.6) Participants are requested to identify the plants from the above step on which they have received or transmitted traditional knowledge (1/plant for which knowledge was received/transmitted).

An interview with the most successful participant would provide a value of 125.

Thus

$$\text{TraLaVi} = \frac{125}{125} = 1$$

The values obtained will indicate the vitality status of the language and TK of the individual in the scale of zero: dead; 0.1-0.25: moribund; 0.25-0.5: endangered; 0.5-0.75: vulnerable; 0.75-1: safe. The TraLaVi values for an entire population can be assessed by taking into consideration a representative sample of the entire population.

Conclusion

Traditional Knowledge facilitates the management of ecosystems and their biological diversity. Lexemes serve as cultural genes by ferrying precise knowledge regarding ecosystems. These lexemes which can be explained both in linguistic as well as ethnobiological terms, are also the building blocks of ethnotaxonomic systems. TraLaVi is an attempt to highlight the possibility of considering ethnotaxonomy as an indicator to assess the health status of indigenous languages and TK. TraLaVi reflects the relationship between individuals/community and their ecosystem and hence can be easily applied to indigenous languages that are ecosystem specific. Thus, TraLaVi could reflect the vitality status of language and TK, both at the individual as well as at the population levels, depending on the nature of the sample. It is simple enough to be applied by ethnobiologists/anthropologists alongside any on-going project. As our approach uses ethnotaxonomy and nomenclature as indicators, it could complement other existing indices that are based on other approaches. TraLaVi could also provide a quick idea of the extent of lexical borrowing and lexical change[72]in a linguistic group. Some of the limitations of TraLaVi could be: 1) Tracing the origin of plant names can be difficult, considering the widespread lexical borrowing. Communities may borrow TK along with a new language[73], or language alone to denote a covert category already recognized by the TK of the community. Since covert categories are not easily revealed in the free-listing processes[74], there is a danger of mistaking the TK too as allochthonous, along with the language. Hence, the researcher has to be skilled enough to take these into account during the interview stages. 2) Lengthy field work is required to collect information on plants during the initial phase. 3) This approach might not be suitable for languages that are not ecosystem specific or communities with members from different ecosystems. Migrant community members are known to provide new names or uses, thereby enriching the body of TK. TraLaVi might find little usability in populations with migrant members. 4) Rooted in linguistic ethnobiology, TraLaVi differs from the popular approaches adopted by linguists such as the use of cognates[75]. Thus, the acceptance level of this concept among linguists might vary. 5) Researchers should consider the age and gender of the respondents while selecting the sample, as these factors might affect the outcome of the free-listing process. 6) During free-listing, respondents tend to list only those terms that are actively used in the language with high frequency while those terms that are rarely used are mentioned with less frequency[76]. TraLaVi in the present form does not consider such valuable passive knowledge. Ethnotaxonomic and nomenclatural systems are not mere classification systems- we hope that future studies will add further evidence to their usability as key indicators of language and traditional knowledge vitality.

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