# The relationship between Northern Khmer people and the forest: A study through ethnobotanical knowledge and vocabulary maintenance

Napongchai Homchong, Siripen Ungsitipoonporn and Candide Simard

**Correspondence**

**Napongchai Homchong[1*], Siripen Ungsitipoonporn[1] and Candide Simard[2]**

[1]Research Institute for Languages and Cultures of Asia, Mahidol University, Nakhon Pathom, Thailand.
[2]School of Pacific Arts, Communication and Education, University of the South Pacific, Suva, Fiji.

*Corresponding Author: homchong.c@gmail.com

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## Research

## Abstract

*Background*: Northern Khmer speakers in five villages in Chuea Phloeng sub-district, Prasat district, Surin province, Thailand, are notable for being a Northern Khmer descendant community who have a long-standing and close relationship with the surrounding Takaw forest. This study examines the relationship between Northern Khmer speakers and the Takaw forest as documented ethnobotanical knowledge and vocabulary maintenance.

*Methods*: The data collection was carried out among participants of two age groups, using quantitative and qualitative methods: a basic vocabulary test, an ethnobotanical knowledge test, which is based on the Traditional Knowledge and Language Vitality Index (Franco *et al.* 2015), and an interview to collect Northern Khmer basic vocabulary and plant names and their associated ethnobotanical knowledge.

*Results*: The statistical analysis shows a significant weak correlation, suggesting that Northern Khmer speakers who have a high level of language proficiency are likely to have ethnobotanical knowledge at a high level. The transmission of knowledge typically starts in childhood, and family members serve as a primary source of knowledge. Children learn about plants and the forest through family activities that they engage in daily, taught by adults generally using the Northern Khmer language.

*Conclusions*: The villagers' experience with wild plants of the Takaw forest has been accumulated and passed down between generations through the use of the Northern Khmer language. This study contributes to a better understanding of how ethnobotanical knowledge is encoded in a language, and how both knowledge and language can be maintained for future generations.

*Keywords*: Northern Khmer, language maintenance, ethnobotanical knowledge, community forest, cultural heritage

## Background

***Northern Khmer language and its speakers***

Northern Khmer belongs to the Mon-Khmer sub-branch in the Austroasiatic language family, and is spoken by approximately 1.4 million people across Thailand, particularly in Surin, Buriram, and Sri Sa Ket provinces (Eberhard *et al.* 2023). It is also considered a dialect of the Khmer language officially spoken in Cambodia (Premsrirat 1997). It has no written form and is mainly transmitted orally between generations; thus, the Royal Society of Thailand has worked with native speakers and linguists to create an orthographic system based on the Thai script to encourage speakers to express their thoughts, document traditional knowledge, and better prepare children for school (the Royal Society of Thailand 2013).

Smalley (1964) has classified the Northern Khmer language as a marginal or regional language, along with Thai, Laos, and Kuj languages commonly spoken in the area. Most Northern Khmer speakers are bilingual, or possibly multilingual, and generally reside with people who speak other languages in a particular community (Smalley 1988). Premsrirat (2018) argues that several non-dominant languages in Thailand, including Northern Khmer, are becoming endangered or show signs of attrition, particularly in their vocabulary and grammar. As reported by Vail (2006), for instance, Northern Khmer speakers in Surin province might be losing their mother tongue due to globalization and modernization, which affect the speakers' lifestyle, access to formal education and mass media, and attitudes towards the language. Furthermore, it is found that the speakers are shifting to speaking Thai increasingly, bringing the language on the verge of attrition, and the domain of language use is solely restricted to their village (Vail 2007).

***The Takaw forest and Northern Khmer community***

The Northern Khmer communities under study is notable for their long-standing and close-knit relationship with the community forest. The Takaw forest is located in the Chuea Phleong sub-district, Prasat district, Surin province, covering a land area of approximately 6 km2, associated with several villages within the sub-district. It is believed to be named after /samaw taakah/ in the Northern Khmer language, referring to a kind of grass commonly found around a swamp where the villagers used to herd cows and buffaloes to feed in the past. Some people stated that its name is derived from /dʌʌm takəw/, a large tree in the forest.

In 2012, the Chuea Phloeng sub-district and Takaw forest received an award from the 14th Green Globe Institute for forest preservation and management (Green Globe Institute 2020). As reported, the forest once confronted illegal encroachment by people in the surrounding areas, which resulted in deforestation and the unlawful occupation of land for habitation, agriculture, and animal husbandry purposes. The village representatives at that time attempted to solve this issue by expropriating the illegally owned forest area and enacting forest regulations to conserve the forest for future generations. The Takaw forest today is considered abundant with wild plants and animals, either land or aquatic animals, and it is one of the few natural water resources the locals can rely on in the dry season. Thus, these efforts in restoring the forest over the years show how highly people value its significance and how it plays an essential role to them.

***Rationale of the study***

This article is inspired by observations made while working on a project to document the ethnobotanical knowledge of Northern Khmer speakers in M8 Ban Khanat Pring, Chuea Phloeng district, Prasat district, Surin province. The project has allowed us to gather information regarding Northern Khmer's language use and way of life in the village. That is, as Northern Khmer descendants, they mainly used the Northern Khmer language to communicate between community members rather than other languages, like Thai and Lao.

According to one interview in this study, one of the M8 Ban Khanat Pring villagers, who grew up close to the Takaw forest, stated that she spent most of her childhood there and that Northern Khmer parents would use their mother tongue to teach children to deal with natural resources. It implies that not only did the Northern Khmer language play a crucial role in daily communication, but it also served as a vehicle for cultural transmission between the village members, especially regarding the ethnobotanical knowledge and traditional practices associated with the forest.

Nevertheless, as globalization and modernization have impacted the community, people are likely to use the Northern Khmer language less and interact with the Takaw forest less frequently, interrupting the transmission of knowledge and perhaps diminishing the role of the two for people in the future. The M8 Ban Khanat Pring villagers are aware of this situation, leading them to participate in the documentation of wild plants using the Northern Khmer language in order to preserve their knowledge for the next generation. Again, this shows how profound their commitment is to the preservation of their mother tongue and the information about plants in the Takaw forest.

A pilot study was conducted with some M8 Ban Khanat Pring villagers to test their Northern Khmer language and plant knowledge using the Traditional Knowledge and Language Vitality Index framework (Franco *et al.* 2015). Interestingly, the findings revealed that the participants who are fluent in the Northern Khmer language can recognize many plant names in their language and are likely to have extensive ethnobotanical knowledge.

Working with Northern Khmer speakers and the remarks from a pilot study above have sparked an interest in exploring further the correlation between the Northern Khmer language and ethnobotanical knowledge. Consequently, this article aims to study the relationship between Northern Khmer speakers and the Takaw forest and to examine the correlation between ethnobotanical knowledge and vocabulary maintenance among Northern Khmer speakers.

**Literature review**

***Language shift and maintenance***

Between 50 and 90 percent of the world's languages are expected to become extinct by the end of the century (Austin & Sallabank 2011). Nettle and Romaine (2000) classify the process of language death into four categories: sudden death, gradual death, radical death, and bottom-to-top death, but the most common aspect is gradual death (Grenoble 2011; Holmes 2013). It is said that when the speakers shift to use other languages instead of transmitting their mother tongue to children, whether voluntarily or not, a language is gradually dying (Lewis & Simon 2010). This circumstance is commonly known as language shift, a linguistic phenomenon that shows changes in the degree of functional use from one language to another (Spolsky 1998).

Language shift can occur either gradually or suddenly, and the speakers may not even be aware of it at the time (Mufwene 2007). It also reduces and diminishes the linguistic competence of individual speakers, leading to a situation that is sometimes labeled as "language loss" or "language attrition" (Pauwels 2016). In other words, when another language takes precedence, it causes the domains of language use shrink. Thus, the speakers gradually lose proficiency in their native language (Holmes 2013). Essentially, the speakers tend to shift to speak a majority language, a more advantageous, dominant, and prestigious language compared to other languages in that region, such as national languages and lingua franca. Shifting in language use shows the difference in status and power between two languages that can be due to urbanization, globalization, and social and reflect cultural dislocations (Grenoble 2011).

In addition, language shift affects linguistic features, including lexical features. According to Wolfram (2004), one of the signs of language attrition is when loanwords or borrowings from another language replace lexical items in a particular language, so the speakers' lexical repertoire varies and depends on the familiarity with the words in some domains. Moreover, the specific or less frequently used domains tend to disappear first, while the more widely and frequently used ones persist longer (Romaine 2012). Previous studies have showed that the use of specific words, especially those traditional way of life-related lexical items, decrease due to language shift in such communities. The case of the Yorùbá language (Fabunmi & Salawu 2005), for instance, showed that the Yorùbá lexical items were replaced by loanwords from English. The Yorùbá speakers could also use general terms proficiently but were starting to forget the specific names for insects, birds, animals, snakes, and vegetables. In another case, of the N|uu language (Sands *et al.* 2007), there might be a loss of terms associated with traditional ways of life. Some N|uu speakers could not recognize plant and animal terms because they were unfamiliar with them, while those who grew up with foraging could. These case studies showed the effects of language shift at the lexical level that might lead the speakers to abandon certain lexical words and eventually cause them to disappear.

Even though many languages are disappearing, efforts have been undertaken by researchers and speakers to prevent or at least reduce the speed of disappearing languages, which raises the question of how to preserve a language. It leads to the focus on language maintenance, described by Spolsky (1998: 124) as "a situation where speakers continue to use a language even when there is a new language available." Language maintenance demonstrates how language is used continuously despite being impacted by other regional or socially dominant languages. Fishman (1991) asserts that intergenerational transmission affects whether a language persists, and if it does not continue, a speech community is considered to have switched to another language.

Holmes (2013: 73) states that it is challenging to specify the factors contributing to maintaining a language for its speakers in a particular community. Those factors might include a) the pattern of language use, b) demographic factors, and c) attitudes to minority languages. Similarly, Pauwels (2016) points out two main groupings of factors: the first group is generation, age, gender, and endogamy, and the second group is the domain of language use, family or home domain, the domain of friendship, and domains of worship, education, and employment. The case study of the Black Tai community

(Chakshuraksa 2003) shows how intermarriage between members, formal education, and the media cause the speakers to shift to the Thai language. Despite this, the Tai language is well-maintained because the speakers have positive attitudes towards the language and culture, which they transmit to their children. It also underlines the significance of language use domains that allow the speakers to use their language despite being dominated by another language.

Apart from those factors, some recent research has discovered that traditional ecological knowledge, or TEK, can play a role in language maintenance, or even prevent the loss of language (Wilder *et al.* 2016). According to the concept of biocultural diversity, or BCD, the three main components of the world's diversity are biological, cultural, and linguistic diversities. They are believed to be interconnected and cannot exist in separate or parallel realms (Maffi & Dilts 2014). It emphasizes the role of language as a vehicle for the transmission of knowledge, cultural values, and practices (Maffi 2005). The study by Hepworth (2008), for instance, shows the relevance of ethnobotanical knowledge in preserving the Kisambaa language even as its speakers switch to using Kiswahili. That is, Kisambaa continues to be prominent in plant nomenclature and intergenerational transmission of plant practices and knowledge. As a result, those lexical items have not been lost or replaced, but have instead survived in terms of lexical items of particular significance.

***Ethnobotanical knowledge***

Berkes (1993) defines the term traditional ecological knowledge, or TEK, as "a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment." The concept of TEK is used in this literature review for a better understanding of ethnobotanical knowledge. Many field studies have focused on TEK in various communities, including ethnobotany, which specifically focuses on people and plants. Ethnobotany is now defined as a field study examining the relationship between human populations and the botanical environment (Albuquerque *et al.* 2017: 2). Ethnobotanical research was initially carried out by botanists who were interested in how humans use plants but it has now broadened to integrate other fields, bringing different perspectives and a variety of techniques and methods for gathering and analyzing data about plants from communities all over the world. According to Martin (1995), ethnobotanical research involves interdisciplinary collaborations with six field studies, including botany, ethnopharmacology, anthropology, ecology, economics, and linguistics.

The term ethnobotanical knowledge is generally used to refer to a people's specific knowledge of plants, practices, and beliefs related to plants. In Thailand, for instance, research has been conducted to study ethnobotanical knowledge among people in different areas, especially those living close to the forest, such as the community forest at Ban Khao Raow Tian Tong in Chai Nat province (Chaiyong *et al.* 2023), the Kok Nhong Phok Forest in Maha Sarakam province (Saisor *et al.* 2021), and the Don Sawan and Don Mor Thong Forests in Nong Khai province (Suksri *et al.* 2005). These studies showed how the locals in each area utilized wild plants in their daily lives for food, medicine, wooden material, handicrafts, fuel, and other uses. These studies also demonstrated the importance of ethnobotanical knowledge to people lives as they acknowledged how the plants they depend on and benefit from, particularly food and medicine, are essential to their existence.

As with TEK, this specific knowledge is cumulatively held by the members of a particular community, accumulated from experience, and passed down from one person to another. According to Cavalli-Sforza and Feldman (1981), there are three modes of cultural transmission involved in the transfer of such knowledge: vertical transmission (from parents to children), horizontal transmission (from peers to peers), and oblique transmission (from the oldest to the youngest). In addition, Ruddle (1993) points out that the transmission of knowledge between individuals in any society is a complex and fundamental process ingrained within its deep socio-cultural structure. Previous studies illustrate how these modes operate. In the Cunyin Manazo community of Argentina, Lozada *et al.* (2006) found that the locals learned about wild plants mostly vertically, beginning at an early age through observation, instruction, and group activities, with family members serving as the main source of knowledge. Similarly, in Thailand, Setalaphruk and Price (2007) found that interactions with family members and community members were the main ways for children to obtain wild foods knowledge, showing that knowledge was passed down through the generations.

The majority of the world's TEK is passed down orally among members of particular communities (Romaine 2010; Nettle & Romaine 2000). Thus, local languages play a crucial role in the transference of plant knowledge as a vehicle of cultural transmission (Hepworth 2008; Fadiman & Gobbo 2022). Nevertheless, nowadays the role of TEK and ethnobotanical knowledge in many societies are radically diminishing as a result of various factors modernization that reduce the necessity of plant uses and the interactions with plants (e.g., Sunkar *et al.* 2021; Ungsitipoonporn *et al.* 2022). Interestingly, numerous studies have discovered a link between the loss of local languages and the loss of plant knowledge, as with TEK (see further Benz *et al.* 2000; Cámara-Leret & Bascompte 2021; Saynes-Vásquez *et al.* 2013). In the case study of Mixtec people in Mexico,

Aparicio *et al.* (2021) reveal the factors affecting the people's knowledge and plant uses, including age, gender, education, and modernization. This study further highlights the loss of Mixtec language and ethnobotanical knowledge, given that Mixtec plant names are rapidly disappearing from the repertoire of those who still speak the Mixtec language, either because they have forgotten the names of the plants or because they remember the names but do not acquire their meanings.

Plant names have long been studied as repositories of TEK among researchers, their nomenclature can reflect people's knowledge embodied in such names (Franco & Narasimhan 2009). For example, Hidayati *et al.* (2022) analyze the folk food plant names of the Kanekes community in Indonesia, finding that plant names contain TEK associated with morphology, ecology, utility, and quality categories. This study also emphasizes the significance of folk plant names as a condensed form of TEK, if these names are lost, so is the knowledge stored in them. The importance of plant names is also noted by Aparicio *et al.* (2021) who state that the name becomes meaningless if the plant is not used any more. In other words, people would forget the names of plants if they stopped using them.

The linkage between language and TEK has been integrated into a framework using the nomenclature in a language as an indicator. The Traditional Knowledge and Language Vitality Index, or TraLaVi index, was initially developed by Franco *et al.* (2015) to evaluate the vitality of language and knowledge. This framework is predicated on the idea that lexical inventories connected with a community's specific cultural domains can be used as a key to retrieve knowledge encoded in those items known among members of such communities. Given case studies by Hidayati *et al.* (2017) and Hidayati *et al.* (2018), the TraLaVi index can demonstrate how people in each community retain TEK related to the environment through the use of languages. It also indicates the ability of people to recall and maintain their knowledge, and it emphasizes the importance of L1 language in storing TEK in a community where members are bilingual speakers or use more than one language.

As presented here, the literature review attempts to provide a grounded understanding of language and ethnobotanical knowledge as TEK. It shows how the knowledge is passed down among community members and how important it is to people's survival and existence. Language serves as a means of communication and is believed to be a repository of the knowledge its speakers have accumulated from interactions and experiences with their surroundings. It will also help in explaining the design of the present study.

## Materials and Methods

***Study area***

Chuea Phloeng sub-district is located in Prasat district on the south-west side of Surin province, about 20 kilometers from the center, covering a land area of approximately 32 km2. The landscape is mostly plateau and lowland, with a community forest and natural water resources scattered throughout the area. The sub-district currently covers 12 villages within the area; however, this study was conducted in the villages that are geographically closet to the Takaw forest, including M2 Ban Ramboe, M7 Ban Samet, M8 Ban Khanat Pring, M9 Ban Nong Soong, and M12 Chuea Phloeng Pattana (Figure 1). The five villages cover a land area of approximately 5 km2. Each village was once part of a densely forested location before people in the nearby area cleared the land since they considered the area relatively plentiful at that time and suitable for habitation and cultivation. Moreover, as far as surveyed, most of the populations in these villages were born in Northern Khmer-speaking areas, while other languages like Thai, Lao, and Kuy are also spoken. They mainly work in agriculture, as their ancestors, but also have other jobs such as industrial labor, freelancing, and silk weaving, the latter being more common among Northern Khmer women. They are also accustomed to gathering wild plants in the Takaw forest because they live nearby or have paddy fields surrounding the Takaw forest area.

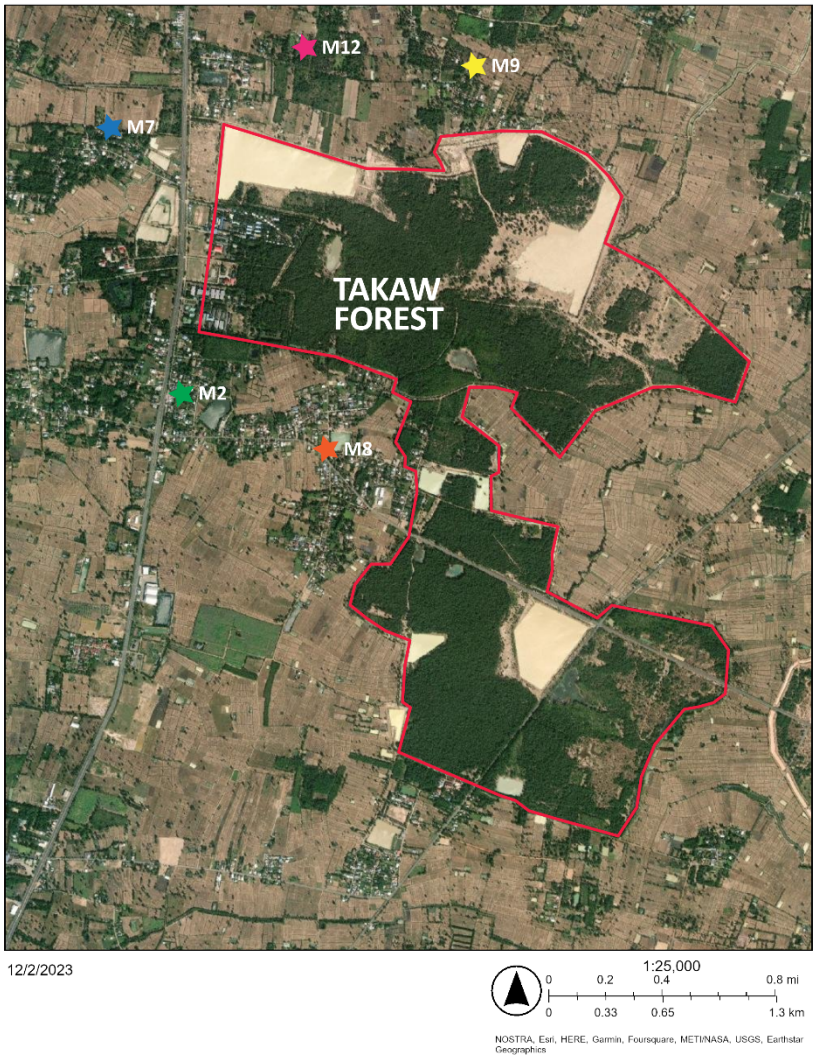


Figure 1. The location of five villages and Takaw forest

***Data collection***

This study employs quantitative and qualitative methods for data collection, which is based on the Traditional Knowledge and Language Vitality Index, or TraLaVi index (Franco *et al.* 2015). The methodology has been reviewed and approved by IPSR-IRB, Institute for Population and Social Research, Mahidol University, with the ethical approval certificate number 2019/09-365. The research tools include a basic vocabulary test, an ethnobotanical knowledge test, and an interview. All lexical items collected in this study are transcribed into IPA (International Phonetic Alphabet) following the phonology used to create the Northern Khmer orthography (see The Royal Society of Thailand 2013). Before collecting any data, all participants were fully informed about the objectives of this study and signed a consent form to affirm their willingness to participate, which demanded approximately 1.30 to 2 hours for each participant. The participant selection, the research tools, the procedure, and the data analysis are presented in detail below.

***Participant selection***

This study divides participants into two different age groups, selected among the people who lived in the studied area during the data collection process. Participant selection for each group is further described below.

A first group of 25 Northern Khmer speakers aged between 60 and 85 was selected using a purposive sampling technique in order to identify the best-known plants from the Takaw forest (see EK test below). The participants include 12 males (48%) and 13 females (52%), with an average age of 70.72 years old. They were selected because they are considered by the other villagers to have the most expertise with wild plants and the Takaw forest.

A second group of participants includes 75 Northern Khmer speakers aged between 30 and 59, selecting 15 participants from each village using a purposive sampling technique, for which gender, education, and occupation are not taken into account. The participants include 13 males (17.33%) and 62 females (82.67%), with an average age of 49.9 years old. Most of them (77.33%) are bilingual and generally speak Northern Khmer and Thai in daily communication, while the remaining participants (22.67%) use Northern Khmer, Thai, and Lao, particularly those in M12 Chuea Phloeng Pattana. All participants declare to have experience with wild plants and the Takaw forest and are mostly engaged in agricultural practices.

It should be, however, stated that the data presented in this study was taken entirely from the participants in the second group; those in the first group solely assisted in preparing the EK test to examine the second group regarding their ethnobotanical knowledge.

**Research tools**

The tools used in this study include the following;

A) The basic vocabulary test (BV test) contains 150 vocabulary words in the Northern Khmer language, mainly taken from the Matisoff-200-wordlist or CALMSEA (Matisoff 1978). The word list is considered suitable for studying Southeast Asia languages; however, Hongladarom (2000) recommends that researchers should take the appropriateness of the target language into account when using the list. As a result, the words on the BV test were selected based on their relevance to the Northern Khmer's way of life, so that they are pertinent to their culture and free of any sensitive or confusing meanings. The 150 words were also translated from English into Northern Khmer and Thai, and native Northern Khmer speakers reviewed the translation.

B) The ethnobotanical knowledge test (EK test) is created based on the methods of the TraLaVi index, which includes five criteria to evaluate language and ethnobotanical knowledge associated with plants in the Takaw forest;

- *Criterion A: Language priority* compares the time it takes to recall 25 plant names in the Takaw forest in Northern Khmer and Thai using a free-listing method.
- *Criterion B: Retrieval of information* focuses on the list of Northern Khmer plant names listed by each participant in criterion A.
- *Criterion C: Knowledge erosion* concerns the participants' ability in explaining their ethnobotanical knowledge of Northern Khmer plant names listed in criterion A.
- *Criterion D: Lexical recognition* concerns the ability to visually identify the 25 salient plants in the Takaw forest by looking at photographs of the plants.
- *Criterion E: Social support for exchange of TK* concerns the source of plant knowledge that the participants correctly identified in criterion D.

In preparation for the EK test, a first step was carried out to collect Northern Khmer plant names from a first participant group that they are familiar with or utilize the forest daily. The data was collected using a free-listing method, in which the total number of plant names obtained was 185. All plant names were analyzed with the Visual Anthropac – Freelists 1.0 program according to their frequency, average rank, and salience. The first-25 ranked plant names obtained in this way are used to test the second participant group for criteria D and E.

C) An interview is conducted to collect information about the participants' way of life, language use, and childhood experiences with plants and the Takaw forest. All the interviews are recorded with the consent given by the participants before starting the process. The following examples of guideline questions are created to prepare for the interviews:

- Can you narrate your childhood? How was your life at that time?
- When you enter the forest, who do you go with?
- What are your purposes to enter the forest?
- When you enter the forest, what language do you speak?
- What kind of plants in the forest do you use the most?
- When you are at home, what language do you speak?

***Procedure***

This study divides the data collection into two stages following the TraLaVi index methodology. The first data collection was started in February 2020 to obtain the most salient plants in Takaw forest from the first participant group. Following that,

the second stage was conducted in July 2020 to test the second participant group using the basic vocabulary and ethnobotanical knowledge tests and to interview them individually. The following is a detailed procedure:

The BV test started first. The 150 words on the test were divided into 15 sets of 10 words to avoid participants becoming exhausted. The tested words were provided in Thai, and the participants were required to give Northern Khmer equivalent. The number of words correctly answered determines the outcome. Each correct word scores one, while an incorrect word scores zero. The test has a 150-point maximum score.

Next, the EK test has a total score of 125, divided into 25 points for each criterion. The test started with criteria A and B, followed by criteria C, D, and E, respectively. Criteria A and B were concurrently conducted, and the participants were required to freely list plant names from the Takaw forest in each language, starting with Thai before Northern Khmer, in order to avoid translating from Northern Khmer to Thai. They could spend as much time as they needed and stop the process whenever necessary or if they could not think of any more plant names in any language. The time taken to complete the task and the total plant names were recorded. The outcome for criterion A is calculated as follows: if the time taken to complete the free-listing in Northern Khmer is lower than in Thai, the score is 25. If the time in the free-listing for the two languages is equal, the score is also 25. If the time for the Northern Khmer is higher than that of the Thai, the score is 15 when the Northern Khmer list is complete but zero when incomplete. Meanwhile, the outcome of criterion B is determined by the number of plant names listed by each participant.

According to the list of plant names in criterion A, criterion C required the participants to explain other metaphorical meanings of each plant that they know or believe to be correct and the plant utilization that they are familiar with or have experienced about such plants such as edible foods, medicine, wooden material, ritual plants, and others. The number of plant names successfully described by the participants and how the plants are useful determines the outcome for this criterion. Each plant name has a score of one. If they cannot provide any information about each, it scores zero.

In criterion D, the participants were required to look at the photographs of 25 plants given and correctly identify their names. Most of the plant photographs were taken from the project "Digital documentation of the botanical knowledge of Northern Khmer speakers: community members, botanists, and linguists working together," with oral permission from the project director to use the photographs. However, it should be noted that the fieldwork for this study was not undertaken during a blooming season, and due to time constraints, it was challenging to find some plants to photograph because the project did not cover some plants on the list. It caused the use of low-quality and insufficient photographs for creating the test. For this criterion, the outcome is determined by the number of plant names accurately recognized and identified. Each correct plant name scores one, and an incorrect one scores zero.

Lastly, criterion E required the participants to explain how they know each plant based on the list of plant names successfully identified in criterion D. If the answer to any of the plants in criterion D was incorrect, it was skipped in this criterion. The number of plant names they explained similarly to criterion D generated the outcome for this criterion.

After the tests were completed, an interview was conducted with each participant following the question guidelines prepared; however, they could be altered during the interview depending on how the conversation between the participants and me was going.

**Data analysis**

***Statistical correlation***

This study employs Spearman's correlation to examine a correlation between data on the BV and EK tests. It is a non-parametric statistic test that measures the strength of a monotonic correlation between two variables. When Spearman's rho *(ρ)* is close to ±1, it shows a stronger monotonic correlation. The statistical analysis runs on the PASW Statistics 18 program.

***TraLaVi score***

The TraLaVi formula (Franco *et al.* 2015) is calculated using the data from the EK test to examine the vitality of Northern Khmer language and ethnobotanical knowledge of plants in the Takaw forest. The following is the formula:

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

Where "X" is the score obtained from the participants using the test, and "125" is the total score. The result is interpreted according to the following criteria: (0) = dead, (0.1 – 0.25) = moribund, (0.26 – 0.5) = endangered, (0.51 – 0.75) = vulnerable, and (0.76 – 1) = safe.

***Qualitative analysis***

Qualitative data from the transcribed interviews were analyzed to highlight the recurrent themes to help better understand the findings of this study.

## Results and Discussion

**The correlation between Northern Khmer language and ethnobotanical knowledge**

The Table 1 summarizes the total data collected from the participants in the five villages using the BV and EK tests. It should be noted that L1 refers to the Northern Khmer language and L2 refers to the Thai language. The asterisk indicates that the free-listing process was not completed. ID refers to the code associated with each participant to maintain their anonymity. The results of the BV test and EK test will be discussed first, before a discussion of the TraLaVi final score.

Table 1. The overall data summary

| ID | Sex | Age | BV test | EK test | | | | | | | Total score | TraLaVi score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Time | | A | B | C | D | E | | |
| | | | | L1 | L2 | | | | | | | |
| G2-001 | F | 45 | 147 | 373 | 505* | 25 | 25 | 25 | 22 | 22 | 119 | 0.952 |
| G2-002 | F | 53 | 146 | 184 | 399 | 25 | 25 | 25 | 23 | 23 | 121 | 0.968 |
| G2-003 | F | 55 | 148 | 286 | 612 | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-004 | F | 57 | 150 | 265 | 541 | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-005 | F | 43 | 149 | 142 | 997 | 25 | 25 | 25 | 23 | 23 | 121 | 0.968 |
| G2-006 | M | 42 | 147 | 232 | 352 | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-007 | F | 53 | 149 | 241 | 645 | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-008 | M | 43 | 150 | 217 | 1140 | 25 | 25 | 24 | 25 | 25 | 124 | 0.992 |
| G2-009 | F | 52 | 150 | 571* | 911* | 0 | 25 | 25 | 21 | 21 | 92 | 0.736 |
| G2-010 | F | 49 | 148 | 294 | 1283 | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-011 | F | 42 | 148 | 462 | 335* | 25 | 25 | 25 | 22 | 22 | 119 | 0.952 |
| G2-012 | F | 51 | 147 | 328 | 491 | 25 | 25 | 25 | 18 | 18 | 111 | 0.888 |
| G2-013 | F | 58 | 146 | 555 | 706* | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-014 | F | 55 | 141 | 291* | 250* | 0 | 14 | 14 | 14 | 14 | 56 | 0.448 |
| G2-015 | M | 57 | 142 | 280 | 347* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-016 | F | 51 | 147 | 321 | 828 | 25 | 25 | 25 | 21 | 21 | 117 | 0.936 |
| G2-017 | F | 51 | 148 | 888 | 1248 | 25 | 25 | 25 | 16 | 16 | 107 | 0.856 |
| G2-018 | M | 36 | 142 | 300 | 766 | 25 | 25 | 24 | 15 | 15 | 104 | 0.832 |
| G2-019 | M | 42 | 147 | 350 | 423 | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-020 | F | 49 | 149 | 240 | 708 | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-021 | F | 32 | 146 | 500* | 360* | 0 | 18 | 18 | 19 | 19 | 74 | 0.592 |
| G2-022 | F | 45 | 147 | 219 | 592 | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-023 | M | 56 | 143 | 432 | 418 | 15 | 25 | 25 | 17 | 17 | 99 | 0.792 |
| G2-024 | F | 30 | 144 | 555 | 374 | 15 | 25 | 25 | 18 | 18 | 101 | 0.808 |
| G2-025 | F | 50 | 147 | 713* | 555 | 0 | 22 | 22 | 15 | 15 | 74 | 0.592 |
| G2-026 | F | 49 | 148 | 351 | 702* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-027 | F | 57 | 148 | 188 | 594* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-028 | F | 59 | 150 | 440 | 591 | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-029 | F | 40 | 149 | 421 | 547* | 25 | 25 | 25 | 22 | 22 | 119 | 0.952 |
| G2-030 | F | 51 | 146 | 288 | 518 | 25 | 25 | 25 | 17 | 17 | 109 | 0.872 |
| G2-031 | F | 56 | 145 | 238 | 480 | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-032 | F | 46 | 150 | 230 | 339 | 25 | 25 | 25 | 21 | 21 | 117 | 0.936 |
| G2-033 | F | 55 | 150 | 253 | 325* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| G2-034 | F | 55 | 149 | 253 | 433* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-035 | F | 52 | 147 | 287 | 278* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-036 | F | 53 | 146 | 147 | 299 | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-037 | F | 55 | 149 | 235 | 364* | 25 | 25 | 25 | 22 | 22 | 119 | 0.952 |
| G2-038 | F | 58 | 148 | 293 | 424 | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-039 | F | 48 | 148 | 230 | 337* | 25 | 25 | 25 | 18 | 18 | 111 | 0.888 |
| G2-040 | F | 38 | 148 | 444 | 495* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-041 | F | 42 | 148 | 147 | 221* | 25 | 25 | 25 | 15 | 15 | 105 | 0.84 |
| G2-042 | F | 48 | 149 | 689 | 333* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-043 | F | 50 | 148 | 263 | 337* | 25 | 25 | 25 | 16 | 16 | 107 | 0.856 |
| G2-044 | F | 52 | 148 | 271* | 157* | 0 | 25 | 25 | 22 | 22 | 94 | 0.752 |
| G2-045 | F | 58 | 136 | 406 | 490 | 25 | 18 | 18 | 8 | 8 | 77 | 0.616 |
| G2-046 | M | 47 | 148 | 358 | 491* | 25 | 25 | 25 | 19 | 19 | 113 | 0.904 |
| G2-047 | F | 55 | 148 | 272 | 572 | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-048 | M | 53 | 150 | 521 | 420* | 25 | 25 | 25 | 22 | 22 | 119 | 0.952 |
| G2-049 | F | 58 | 149 | 306 | 345* | 25 | 25 | 25 | 22 | 22 | 119 | 0.952 |
| G2-050 | F | 47 | 148 | 509 | 600* | 25 | 25 | 25 | 20 | 20 | 115 | 0.92 |
| G2-051 | M | 57 | 145 | 279* | 187* | 25 | 25 | 25 | 21 | 21 | 117 | 0.936 |
| G2-052 | F | 56 | 148 | 240 | 374 | 25 | 21 | 21 | 19 | 19 | 105 | 0.84 |
| G2-053 | F | 42 | 150 | 169 | 377 | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-054 | M | 39 | 147 | 275 | 730* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-055 | F | 40 | 149 | 198 | 326* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-056 | M | 40 | 150 | 266 | 444* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-057 | F | 51 | 149 | 156 | 325* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-058 | F | 51 | 146 | 242* | 359* | 0 | 14 | 14 | 19 | 19 | 66 | 0.528 |
| G2-059 | M | 55 | 149 | 269* | 490* | 0 | 13 | 13 | 20 | 20 | 66 | 0.528 |
| G2-060 | M | 59 | 148 | 184 | 257* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-061 | F | 57 | 148 | 198 | 402* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-062 | F | 57 | 150 | 535 | 212* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-063 | F | 58 | 149 | 307 | 417* | 25 | 25 | 25 | 21 | 21 | 117 | 0.936 |
| G2-064 | F | 46 | 148 | 579 | 371* | 25 | 25 | 25 | 18 | 18 | 111 | 0.888 |
| G2-065 | F | 57 | 147 | 146 | 644 | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-066 | F | 49 | 149 | 174 | 493* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-067 | F | 49 | 150 | 270 | 553 | 25 | 25 | 25 | 23 | 23 | 121 | 0.968 |
| G2-068 | F | 55 | 149 | 470 | 405* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-069 | F | 54 | 150 | 352 | 833 | 25 | 25 | 25 | 17 | 17 | 109 | 0.872 |
| G2-070 | F | 49 | 148 | 282 | 331 | 25 | 25 | 25 | 23 | 23 | 121 | 0.968 |
| G2-071 | F | 57 | 147 | 331 | 282* | 25 | 25 | 25 | 23 | 23 | 121 | 0.968 |
| G2-072 | F | 58 | 146 | 321 | 311* | 25 | 25 | 25 | 24 | 24 | 123 | 0.984 |
| G2-073 | F | 55 | 149 | 329 | 627* | 25 | 25 | 25 | 25 | 25 | 125 | 1 |
| G2-074 | F | 43 | 141 | 608* | 606* | 0 | 16 | 16 | 14 | 14 | 60 | 0.48 |
| G2-075 | F | 30 | 149 | 603 | 677 | 25 | 25 | 25 | 14 | 14 | 103 | 0.824 |

**Basic vocabulary test**

The results of the BV test show that the participants received scores ranging from 136 to 150, with an average score of 147.2. Most participants received scores of 148 (26.67%), followed by scores of 149 (21.33%) and 150 (16%). Moreover, 111 words on the test (74%) were recognized by all participants, while the remaining 39 words (26%) were not. When asking participants about the words they did not recognize, most of them typically claimed to know such word but could not think of it because they felt shy and excited throughout the data collection process, causing them to forget the words unintentionally.

The 39 unknown words should be taken into consideration, and some remarks on these words should be highlighted. For instance, the word (B046) /tuuk/ 'boat' was recognized by only 46 participants (61.33%). When considering the geographical setting, there is no canal or river nearby the studied area. Although natural water resources are dispersed throughout the

community, the locals solely use them for home consumption and agriculture, not for transportation. This example shows that the word (B046) /tuuk/ 'boat' is infrequently used by Northern Khmer speakers in the villages, so that it could disappear form their lexicon. This finding is in line with Akharawatthanakun (2013) who found that lexical items that are less frequently used and infrequently seen in daily life tend to disappear among the speakers.

It is also observed that several Northern Khmer words can be used interchangeably. For instance, the word (B099) /pʰaɲiəh/ 'awake' was recognized by 68 participants (90.67%). Interestingly, they claimed to occasionally use the word /krɒɒk/ 'wake up' instead. Despite their similar meanings, one of the participants explained that they generally use (B099) /pʰaɲiəh/ when they become conscious after sleeping all night but not yet getting up from bed, whereas /krɒɒk/ is used when they wake up in the morning. As a result, some speakers prefer to use /krɒɒk/ instead of (B099) /pʰaɲiəh/ because both words are actions they do regularly. Another word (B043) /kamol/ 'rounded' was recognized by 43 participants only (57.33%) as it is generally substituted by other terms when tested such as /kamuul/, /kawɔŋ/, and /kɔŋwɔŋ/, which all mean 'rounded' in Northern Khmer. These examples show the replacement of words that might cause a substituted word to become less used and forgotten.

As reported here, the BV test indicates that the participants are familiar with most basic vocabulary words on the test, showing that they retain a relatively high level of language proficiency in Northern Khmer as their L1 language. However, it should be noted that the Northern Khmer language spoken in this area is showing signs of language attrition as they are starting to forget some words on the test, which might cause them to become out of use in the future.

**Ethnobotanical knowledge test**

***Criterion A: Language Priority and Criterion B: Retrieval of Information***

For criterion A, the participants were required to freely list plant names from the Takaw forest in Northern Khmer and in Thai, and the time it took them was counted; the results show that most participants (48%) could complete the free-listing task only in Northern Khmer, followed by those who could in both languages (40%), those who could not in both languages (10.67%), and those who could, but only in Thai (1.33%). The average time spent free-listing in Norther Khmer (330.387 seconds) is also less than in Thai (499.733 seconds). Furthermore, in criterion B, the highest number of plant names collected from the free-listing is 25, and the fewest is 13, 68 participants (90.67%) could provide a total of 25 plant names. The findings of criteria A and B indicate that the participants retain a high ability to recognize plant names in their language, suggesting that Northern Khmer as L1 language is more closely associated with plant names in the Takaw forest than Thai, as L2 language. Further analysis using the Spearman's correlation indicates a significantly positive correlation between the BV test and criterion A, $r(75) = 0.326$, $p = 0.004$, given that the participants with a high level of language proficiency are more likely to spend less time in recalling plant names in the Northern Khmer language. This finding corresponds to Hidayati *et al.* (2017), who found that language proficiency correlates with the ratio between time taken in free-listing plant names between the L1 and L2 languages.

**Criterion C: Knowledge Erosion**

For criterion C, the participants were asked to explain metaphorical meanings and utilizations of the plants they listed in criterion B. The participants did not skip any of the plant names, indicating that they were well-versed in ethnobotanical knowledge associated with such names. The results show that most plant names did not contain any metaphorical meanings except for referring to the plant; however, a few plants might have such meanings for the participants, for instance:

(P026) **/kacɒɒk nʌʌk/** 'turtle's nail'
(P089) **/baaj kadaŋ/** 'dried rice'
(P132) **/pʰaneec ʔaŋkɛɛp/** 'frog's eyes'
(P240) **/ʔantuuəŋ sɒɒ/** 'white eel'
(P280) **/samaw ʔac sɛh/** 'horse's manure grass'

Based on the data collected, it is observed that the characteristics of the names are related to a variety of things. As shown in those examples above, plant names, when broken down into words, can be connected to traditional domains such as animals, plants, and parts of the body. For instance, (P026) **/kacɒɒk nʌʌk/**, the word /kacɒɒk/ means 'nail' and /nʌʌk/ means 'turtle,' Northern Khmer speakers refer to it as having features akin to a turtle's nail. This observation is consistent with Addi *et al.* (2022) and Van't Klooster (2021), who shed light on the folk nomenclature and people's perspective on naming and describing plants. That is, people generally name plants by their characteristics, habitat, culture, and use, as well as animals,

places, and body parts. However, because the nomenclature of Northern Khmer plant names is not thoroughly examined in this study, further analysis of those names is suggested.

In addition, a degree of language variation is found in the community. As the Northern Khmer language is generally passed down orally, it could lead one plant name to take several meanings to each participant, making it challenging to discern the names' actual meanings. For instance:

> (P209) **/tapiiəŋ cuu/** the word /tapiiəŋ/ contains two meanings: 'bamboo shoot' and 'pond,' while /cuu/ has only one meaning: 'sour.'
> (P029) **/dɒʔ tuəʔ/** the word /dɒʔ/ contains four meanings: 'milk,' 'pull out,' 'tie,' and 'store water,' while /tuəʔ/ only means 'bruised.'

The plants may not have metaphorical meanings, but the speakers know a lot about their usage, for example for food, medicine, building material, and so on, and practically every part of the plant can be useful such as, stem, leaf, vine, root, and others. For instance:

> (P011) **/ʔaŋkaɲ/** they usually pick its leaflet to make a curry called /salɒɒ ʔaŋkaɲ/.
> (P015) **/kʰlɔŋ/** its stem is taken to serve as a pillar in constructions, and its leaf is woven to make house walls.
> (P125) **/dɒʔ krabɛj/** they boil its vine to make a medicine to increase or improve breast milk supply for Northern Khmer women who might have insufficient milk for babies.
> (P065) **/talompee/** its branch is utilized as a spool used when extracting silk from cocoons.
> (P081) **/saŋkʰər/** they bring its trunk to encircle the holes that contains human excreta, such as a woman's amniotic fluid after giving birth, to prevent /tʰamop/, a spirit that likes to consume excreta things, eating it.

From the examples above, the participants not only recognize plant names but also have ethnobotanical knowledge associated with them. However, it should be noted that some plants, such as (P209) **/tapiiəŋ cuu/**, might be used by one participant but not by another. Some people collect it when ripe to eat, but others avoid it due to the rubbery texture that irritates their throat. The results of criterion C show how Northern Khmer speakers interact with the plants in the Takaw forest and contribute to the body of knowledge obtained from nature. Furthermore, the high level of scores for this criterion indicates that ethnobotanical knowledge erosion is not a concern among Northern Khmer speakers in this generation.

**Criterion D: Lexical Recognition**

Identifying 25 plant names by looking at photographs was likely the most challenging task for the participants. The scores of criterion D ranged broadly from 8 to 25, and only 17 participants (22.7%) obtained a total score of 25. Most participants claimed to know plants but could not recognize them because they were nervous and excited during the test, causing them to be unable to recall their name. As mentioned before, one limitation of this study was the use of low-quality and insufficient photographs for creating the test due to time constraints, which made it difficult for participants to recognize and differentiate between the plants (see Figure 2). Although the plants of the test were considered the most salient of the Takaw forest, the results reveal that Northern Khmer speakers' ability in visual recognition, at least using these stimuli, may not be optimal; however, this conclusion is tentative given the limitation mentioned above.


Figure 2. Examples of plants that are challenging to distinguish for the participants: A (P016) **/tabɛɛɲ/**, and B (P091) **/traac/**.

**Criterion E: Social support for exchange of TK**

Based on the list of plants correctly identified by the participants in criterion D, the results show that 'grandparent' (60.93%) was the most frequently mentioned source of ethnobotanical knowledge of plants in the Takaw forest, followed by 'parents' (38.48%), 'relatives' (0.20%), and 'peers' (0.20%), and finally 'media and books' (0.15%). As shown statistically, the primary sources of ethnobotanical knowledge transmission for Northern Khmer speakers are the people with whom they have interacted, particularly family members, school does not appear to be involved.

**The TraLaVi score**

According to the results in Table 1, the highest score on the EK test is 150, while the lowest is 56, with an average score of 112.92. Based on the TraLaVi assessment, the results yielded a very high overall value of 0.90, indicating that ethnobotanical knowledge and the Northern Khmer language in the community is safe (Franco *et al.* 2015). In summary, the results of the EK test show that Northern Khmer speakers in this study are highly knowledgeable about wild plants in the Takaw forest, particularly with regard to ethnobotanical knowledge as it pertains to the use of the Northern Khmer language. That is, this finding shows that Northern Khmer speakers continue to have a high level of competency in plant recognition and ethnobotanical knowledge through language use. In other words, the results presented here demonstrate the vitality of the Northern Khmer language and ethnobotanical knowledge of the plants in the Takaw forest still exist in the community.

**The statistical correlation of Northern Khmer language and ethnobotanical knowledge**

Based on the data on the BV and EK tests, the Spearman's correlation indicates a significantly positive correlation between the data, $r(75) = 0.344$, $p = 0.003$, implying that Northern Khmer speakers who have a high level of language proficiency in the Northern Khmer language are likely to have ethnobotanical knowledge at a high level. It also suggests that the Northern Khmer language as their L1 language is associated with plant knowledge rather than Thai as their L2 language. That being said, most Northern Khmer speakers in this study are bilingual (or multilingual), the findings show that ethnobotanical knowledge is likely to be transmitted through the use of the Northern Khmer language, even if they can use more than two languages. This argues for the maintenance of Northern Khmer, making the speakers aware of the value of their knowledge to avoid language attrition. In another part of the world, a study by Paniagua-Zambrana *et al.* (2014) found that bilingual speakers in the Southern Amazon can maintain ethnobotanical knowledge better than monolingual speakers.

Despite the weak correlation, the statistical results, as presented here, demonstrate the relationship between language and ethnobotanical knowledge. Although it may be challenging to draw firm conclusions, this finding shows the role of L1 language in storing plant knowledge among Northern Khmer speakers, which supports Hepworth (2008), who noted from the perspective of biocultural diversity that local languages are necessary for conserving the local environment and recognizing and knowing plant medicines and foods vital for livelihood resilience. That is to say, Northern Khmer speakers are likely to preserve their language connected to these plants and the significance they have in their lives, provided they continue to rely on the plant knowledge of the domains they used.

**Language use in childhood**

As previously mentioned, the five Northern Khmer villages can be considered a multilingual community, where four languages are spoken, including Northern Khmer, Thai, Lao, and Kuy. The interviews show that most people in the community were born speaking Northern Khmer as the L1 language and Thai as the L2 language. The Northern Khmer language was used mainly for communication between family members and neighbors in the village. Northern Khmer children learned to speak the L1 orally through their parents and grandparents or other community members whom they interacted with. Thus, they are the primary sources of Northern Khmer language acquisition. Meanwhile, because Thai is generally used by every person in the territory of Thailand as an official language of administration, education, and mass media, it forces Northern Khmer speakers to speak the Thai language, especially when they go outside the village, or to communicate with outsiders. School is the predominant source for learning Thai for Northern Khmer children, this is where they first learn to speak it, and teachers also encouraged children to speak Thai rather than Northern Khmer, even if it is their mother tongue. Interestingly, the interview shows that Northern Khmer children at the time were rigorously forced to speak Thai, so the use of Northern Khmer was prohibited at school. That is to say, some participants claimed to have been punished because they unintentionally spoke the Northern Khmer language with friends by losing a point or paying a fine. This situation is similar to the findings of Vail (2006), who reported that school is one of the major factors pushing Northern Khmer speakers in Surin province to use Thai, as well as the punishment for transgressing students for speaking Northern Khmer in the classroom.

Despite the substantial promotion of using the Thai language in education settings, it seems to have been ineffective for Northern Khmer speakers in this study. They continued to mainly use the mother tongue to communicate with peers who came from surrounding villages during their lunchtime. When they returned home, the Northern Khmer language was the primary language for communication between family members. Thus, it might be said that the proximity of family members

helped in transmitting the language. According to the BV test results, most Northern Khmer speakers in this study retained a high degree of language proficiency in their mother tongue, suggesting that the Northern Khmer language has been their predominant language and the one they are most familiar with since childhood. The data presented here supports Pauwels's (2016) point on the relevance of the family domain in language maintenance. That is, family interaction is essential for sustaining the use of the language in the villages, it is as the parents and grandparents who provide opportunities for their children to continue speaking their mother tongue and become proficient in it. As a result, the Northern Khmer language was more present in their daily lives than other languages spoken in the community at the time.

**The relationship between Northern Khmer people and Takaw forest**

The Takaw forest is a community forest geographically surrounded by rice fields mainly owned by Northern Khmer descendants from neighboring communities. From the interviews, the forest has been an essential natural resource that is free to use for the locals. As with other communities close to the forest in Thailand (e.g., Saisor *et al.* 2021; Suksri *et al.* 2005; Chaiyong *et al.* 2023), Northern Khmer people took advantage of the forest for daily necessities such as food, medicine, wooden material, and firewood, as well as an area for husbandry called in their language /tanlee/ or /tanlee kʰwiiə krabɛj/, meaning field for herding buffaloes, making those who grow up close to it accustomed its wild plants since childhood. One factor leading them to rely on the forest was their living conditions, as they say they were born and raised in villages that faced hardships. That is, in the past, they had no access to public utilities such as electricity, water supply, and transportation, and in many families, the adults could not earn sufficient money from jobs to ensure the family's well-being. Because of this, the forest was a crucial resource where they could forage plants for subsistence.

As shown in criterion C, wild plants in the Takaw forest could be used for a variety of purposes, especially edible plants, which Northern Khmer people generally gathered either all-year round or in a particular seasonal, for example, wild vegetables, fruits, and mushrooms to consume in the household, and even to sell or to exchange for rice or other necessities between members within the village. Moreover, they also collected dried branches or stems from the forest to use as firewood because there was no electricity or cooking gas to burn into charcoal in order to sell in the city. Thus, wild plants in the Takaw forest were available resources that could generate income for the Northern Khmer people in the community through trading, apart from consumption within households. This situation is similar to that described in Somnasang *et al.* (1998) study who found that rural people in the north-east part of Thailand depended on wild food, including plants, as their diet and a resource of income from sales in town markets.

Using medicinal plants to treat illness was another plant utilization in people's daily lives in the past. They struggled to access modern medical treatment because transportation at that time was inconvenient, and the hospital was far from the village. This situation forced them to rely on medicinal plants when they became sick. The interviews show that many plants were taken to treat different diseases, both general and specific ones, particularly poisonous eating disorders and for women giving birth, which affected their lives immediately. Thus, they retained and relied on this specific knowledge, such as knowing how-to collect plants to consume while avoiding poisonous ones, as part of daily life.

From the plant uses above, it can be said that wild plants from the Takaw forest benefited Northern Khmer people in this area and enhanced their well-being. The necessity of using those plants creates a proximity between people, plants, and the forest, leading them to accumulate knowledge through their interactions with plants and the forest. It is in line with Sunkar *et al.* (2020) who also found that interactions with plants are the key to retain ethnobotanical knowledge. Consequently, their ethnobotanical knowledge was and continues to be crucial to them in various ways.

**The transmission of ethnobotanical knowledge**

Most Northern Khmer families were generally extended families, with more than two generations living in the same house. Based on the interviews, Northern Khmer children were involved in the family's daily activities and had specific duties, such as helping parents herd cows and buffaloes to paddy fields or foraging wild food nearby the Takaw forest before going to school in the morning, as well as assisting with planting rice, sowing seeds, and plowing the fields in the farming season. Since the elderly usually went to the forest, the children had an opportunity to accompany them, it was more common to enter the forest in groups than alone, and a group could include members of different generations. As a result, exploring the Takaw forest with others was the starting point for getting acquainted with plants for Northern Khmer children. This finding is in line with previous studies (e.g., Lozada *et al.* 2006; Eyssartier *et al.* 2008; Mattalia *et al.* 2020), showing that the transmission of ethnobotanical knowledge typically starts in early childhood, and the primary sources of knowledge are family members.

Moreover, the transmission of knowledge in the community mainly occurred during traditional activities, where children were part of agricultural and forest-related practices that adults generally do in daily life, such as foraging for wild plants. This is consistent with other studies, notably Setalaphruk and Price (2007), Somnasang *et al.* (1998), and Zarger and Stepp (2004), who found that learning occurred during the extensive interactions among family members when children engaged in the act of gathering plants and animals. Northern Khmer elders generally taught children to know useful plants so that they would use them efficiently, either directly or indirectly, by questioning if they were unsure which plants they were dealing with, as well as through participation in the family's activities and observation. These are the route through which such knowledge was passed down between generations. In addition, some types of specific plants, such as medicinal plants, appear to have been restricted to elders, who gathered them to treat sick children. Although children did not collect these plants themselves, they did learn about them from how others used them. This finding follows Ungsitipoonporn *et al.* (2021) and Turreira-García *et al.* (2017), who found that children learned about the plants by observing when the parents were cooking food, for example.

Despite spending most of their time in school, Northern Khmer children were still familiar with plants and the Takaw forest. As opposed to Saynes-Vásquez *et al.* (2013), who found that time spent in school might limit the opportunity to learn about plants. However, because Northern Khmer children were responsible for helping their family members, they were driven to engage in forest-related activities as part of their daily lives.

**Plant names as repository of Northern Khmer language and ethnobotanical knowledge**

Based on the results of criteria A and B, the Northern Khmer language is more involved in plant recognition and knowledge transmission than other languages spoken in the community, and it is also a medium of communication when entering the Takaw forest. Northern Khmer elders generally taught children ethnobotanical knowledge, introducing them to plant names so they could recognize them. Thus, Northern Khmer plant names are the first element of knowledge about a plant that people can acquire from an early age. This supports the findings of Reyes-García *et al.* (2009), who found that recognition-related features and plant names are more easily acquired than ethnobotanical knowledge skills and are mostly acquired in childhood.

Other studies suggest that people's knowledge related to the environment in a particular community is encoded in local languages (e.g., Benz *et al.* 2000; Wilder *et al.* 2016; Kraisame & Thawornpat 2023). As shown in criteria C, not only Northern Khmer plant names but also information about those mentioned by Northern Khmer speakers may be assembled. It might be said that plant names in the Northern Khmer language are a repository of knowledge crucial for people as a key to retrieving what they have learned about the plants in the Takaw forest, and as such they play a significant role in the knowledge transmission. This finding agrees with those of Aparicio *et al.* (2021) and Addi *et al.* (2022), who noted that the continued use of plants and language impacted the preservation of plant names. Thus, Northern Khmer plant names, as presented in this study, will continue to be maintained as long as its speakers continue to speak their language and rely on information associated with such names in their daily life.

## Conclusion

This study contributes to a better understanding of the relationship between people, language, and the forest. Northern Khmer speakers in five villages have depended on the Takaw forest for subsistence for a long time, and their experience of plants and the forest has been accumulated into a body of knowledge and transmitted between members of the community through language use. The plant knowledge is encoded in the Northern Khmer language, where plant names are a repository of knowledge associated with such plants. As long as they continue using the forest for the many purposes they traditionally have, the knowledge of the plant names and their uses is more likely to be maintained and transmitted. Further research investigating how much the children of today are engaging in their parents and grandparents forest activities would confirm this. As a result, it is possible to conclude that the ethnobotanical knowledge associated with plant names make this a crucial domain that can help to ensure the survival of Northern Khmer language.

## Declarations

**List of abbreviations:** Basic vocabulary test (BV test), Ethnobotanical knowledge test (EK test), Traditional ecological knowledge (TEK), Traditional Knowledge and Language Vitality Index (TraLaVi index)

**Ethics approval and consent to participate:** This study was submitted and approved by IPSR-IRB, Institute for Population and Social Research, Mahidol University, with the ethical approval certificate number 2019/09-365. All participants were fully informed about this study and signed a consent form to affirm their willingness to participate.

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