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Nuosu Horticulturalists' Local Knowledge of Wild Edible Plants and Fungi and Socio-Economic Implications in Yunnan, Southwest China

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Abstract. *The collection and consumption of wild edible plants (WEPs) and fungi is an important part of the foodways of many populations worldwide. Knowledge of WEPs and fungi is considered a significant component of traditional ecological knowledge (TEK), and is greatly impacted by social, economic, political, and cultural contexts and changes. T his study showcases a naturalistic comparison between more traditional villages and villages that were part of a government program to promote walnut production. We document the ethno-species of WEPs and fungi and analyze the corresponding socio-economic implications in an ethnic Nuosu township in the northwest region of Yunnan Province, China. Semi-structured interviews, free lists, household surveys, and cultural consensus analysis were used for data collection and data analysis. We recorded 139 ethno-species of WEPs and fungi, and consensus analysis indicates a good fit of the cultural consensus model with respect to Nuosu people's knowledge on WEPs and fungi. Quantitative analysis shows gender does not have an effect on local knowledge of WEPs and fungi, and different types of villages and travel-time required to collect WEPs and fungi are not correlated with competence scores. However, the correlation between competence scores of WEPs and fungi with gender and travel time show moderate effect-sizes. Age plays an important role in knowledge of WEPs and fungi among Nuosu people in the study township, showing that the older the person, the higher their score. This article illustrates the plight and reality of traditional knowledge about WEPs and fungi of the Nuosu people, revealing a trend that traditional knowledge is gradually changing due to social, economic, and ecological changes.*

Keywords: *wild edible plants and fungi, consensus analysis, Nuosu*

Introduction

Scholars from both the social sciences and the biophysical sciences have long been interested in the complex relationship between humans and their environment, as well as people's knowledge and utilization of natural resources (Berkes et al. 2000; Gadgil et al. 1993; Nesheim et al. 2006). However, the deterioration of traditional cultures and their assimilation into other cultural groups has led to a loss of traditional knowledge across the globe (Trosper et al. 2012). It is also widely recognized that knowledge of wild edible plants (WEPs) and fungi is decreasing in many regions due to a number of factors, including the rapid development of monoculture agriculture and modern food industries, along with corresponding shifts in dietary habits and preferences and a lack of engagement among younger generations (Dweba and Mearns 2011; Ladio 2001; Menendez-Baceta et al. 2011; Pardo-de-Santayana et al. 2005).

WEPs and wild fungi refer to species that are harvested or collected from their natural habitats and used as food for human consumption. In many cases, WEPs and fungi serve a nutritional purpose as food and may also be used as medicine (Pieroni and Quave 2006; Price and Ogle 2008; Rahmatullah et al. 2010). Knowledge of WEPs and fungi has significant direct use value, which

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helps to ensure food security and serves as one of the primary sources of cash income for Indigenous communities (Ghorbani et al. 2012a, 2012b; Menendez-Baceta et al. 2011; Uprety et al. 2012). WEPs and fungi also play an important role in serving as dietary supplements or as famine food in times of scarcity (Dweba and Mearns 2011; Mattalia et al. 2012; Pardo-de-Santayana et al. 2005; Shrestha and Dhillion 2006). Furthermore, WEPs and fungi are potential sources of new species for domestication and provide valuable genetic traits for developing crops through breeding and selection (Ford-Lloyd et al. 2011; Pandey et al. 2006). The collection and consumption of WEPs and fungi is considered a "way of life" that supports vital dietary needs in many societies (Ghorbani et al. 2012a; Setalaphruk and Price 2007; Shrestha and Dhillion 2006). Especially in poor rural areas, WEPs and fungi provide significant support to diet and health (Bharucha and Pretty 2010; Cruz-Garcia and Price 2014). Knowledge of WEPs and fungi is a key component of traditional ecological knowledge (TEK) and is commonly transmitted generationally through socialization within a specific cultural context (Price 2011).

During the past decade, there has been growing interest among scholars in studying WEPs and fungi. Studies have focused on botanical surveys and associated genetic resources (Rana et al. 2011; Tang et al. 2007), nutritional values and chemical compounds (Aberounman and Deokule 2009; Grivetti and Ogle 2000; Salvatore et al. 2005), and people's knowledge and practice of WEPs and fungi (Ghorbani et al. 2012b; González et al. 2010; LaRochelle and Berkes 2003; Reyes-Garcia et al. 2005; Setalaphruk and Price 2007; Teklehaymanot and Giday 2010; Uprety et al. 2012). However, due to fast-paced social change and acculturation processes, TEK of WEPs is declining and even disappearing in the face of modernization and globalization (Ju et al. 2013; Muthu et al. 2006; Setelaphruk and Price 2007; Termote et al. 2011). Meanwhile, the loss of traditional ecological knowledge is one of the major negative factors on the conservation of biological diversity (Keller et al. 2005). Therefore, it is urgent to document and rejuvenate traditional knowledge of WEPs to preserve biological and cultural diversity (Luczaj et al. 2013; Shrestha and Dhillion 2006; Tardio et al. 2006).

WEPs have multiple uses for local people and are also important to agrobiodiversity. However, like in many other parts of the world, the ecology of Ninglang Yi Autonomous County in Lijiang Prefecture, Yunnan, China, where this study took place, is becoming fragile, and agrobiodiversity is being rapidly lost due to a variety of natural and human factors, including deforestation, soil contamination, soil erosion, and climate change (Meng et al. 2011; Willson 2006). Many plant resources that may have potential for future sustainable development are likely vanishing before they have been discovered (Ju et al. 2013). The reduction of plant diversity also leads to the transformation and/or loss of the associated traditional knowledge (Khasbagan 2008). Hence, the documentation and evaluation of WEPs and fungi and related traditional knowledge become critically important to conserve cultural and biological diversity. This study may provide insights on the reasons traditional knowledge has been declining and may therefore guide proper conservation processes of WEPs and fungi.

A substantial amount of scholarly research has explored taxonomy, knowledge transmission, and nutritional and chemical aspects of WEPs and fungi across the globe, including in China (Huber et al. 2010; Kang et al. 2012; Wu 2015). This study focuses on documenting ethno-species of WEPs and fungi and investigating the correlation between demographic variables (gender, age, village location, and travel time to collect WEPs and fungi) and competence scores of respondents.

Case studies examining the relationship between gender and knowledge of WEPs and fungi reveal complexity and ambiguity, despite the fact that there may be a tendency for women to predominate as WEP and fungi gatherers in many cultures (Price and Ogle 2008). For example, women and girls know more WEPs than boys and men in Northeast Thailand, the Lao PDR, and Vietnam, and it is assumed that women's greater knowledge of WEPs is associated with their important role in gathering (Garcia 2006; Price and Ogle 2008). Furthermore, certain WEP species have distinct gender elements; in Ogoye-Ndegwa and Aagaard-Hansen's (2006) work in Western Kenya with the Luo, it was shown that collecting vegetables is considered women's and girl's work, while both men and women can collect the same species for medicinal use. However, the pattern of women's predominance as gatherers is subject to change in contemporary circumstances. Turner (2003) illustrates that gathering was the traditional work of women among Indigenous societies of northwestern North America, but her later work with Clifton (Turner and Clifton 2006) shows that men and women in those societies collect seaweed together. Goebel's (2003) work in Zimbabwe also indicates that collecting WEPs is not always women's work. This complexity and ambiguity requires researchers to pay attention to cultural changes and to comprehend the development of TEK related to WEPs and fungi within the cultural context of the communities where they work.

The relationship between age and knowledge of WEPs and fungi also shows dynamic aspects as it varies across cultures and changes over time. Ogle and Grivetti (1985) discovered a significant association between increasing age and the number of WEPs utilized in Eswatini. According to their study, school-age Swazi children knew more total species than adults, Swazi males recognized significantly fewer species than females. Whereas Yineger and Yewhalaw (2007) found that there was no significant correlation between age and the number of WEP species reported in Southwestern Ethiopia. Zarger and Stepp's (2004) research with the Highland Maya found that both boys and girls have the same level of knowledge about WEPs as they approach adulthood.

Knowledge of WEPs is not only affected by cultural context, but also is influenced by social and economic development and changes. A social stigma related to collecting WEPs and fungi is commonly observed across cultures. In this study, village location as a variable is closely tied to socioeconomic status of the Nuosu (villages closer to main roads and involved in the market economy are considered "better" and more developed). Wilken (1970) pointed out that gathered plants and animals have been regarded with mixed feelings in Highland Mexico; they are part of the traditional economy but generally have been associated with poverty. Similar attitudes prevail in modern Tlaxcala, where WEPs are collected primarily by the poor and only occasionally by the more prosperous. Ogle and Grivetti's (1985) work resonated with this finding as well; in Eswatini, a stigma is attached to consuming WEPs, and a significant percentage of people would not serve them to guests. This study addresses questions including: the categories and the uses of WEPs and fungi for local farmers in Zhanhe; if members of the study community share a cultural model of TEK related to WEPs and fungi; and if distribution of TEK about WEPs and fungi varies based on key demographic variables, including age, gender, travel time to collect WEPs and fungi, and village location.

Methods

Study Site

The study location is Ninglang Yi Autonomous County (Figure 1), also known as Xiao Liangshan (小凉山), located in Lijiang Prefecture, Yunnan Province, in Southwest China. Located on the edge of the Qinghai-Tibet Plateau, the region has long been a cultural crossroads between the Han Chinese and various ethnic groups, such as the Nuosu, which is a sub-group of the Yi and the primary focus in this study. Given

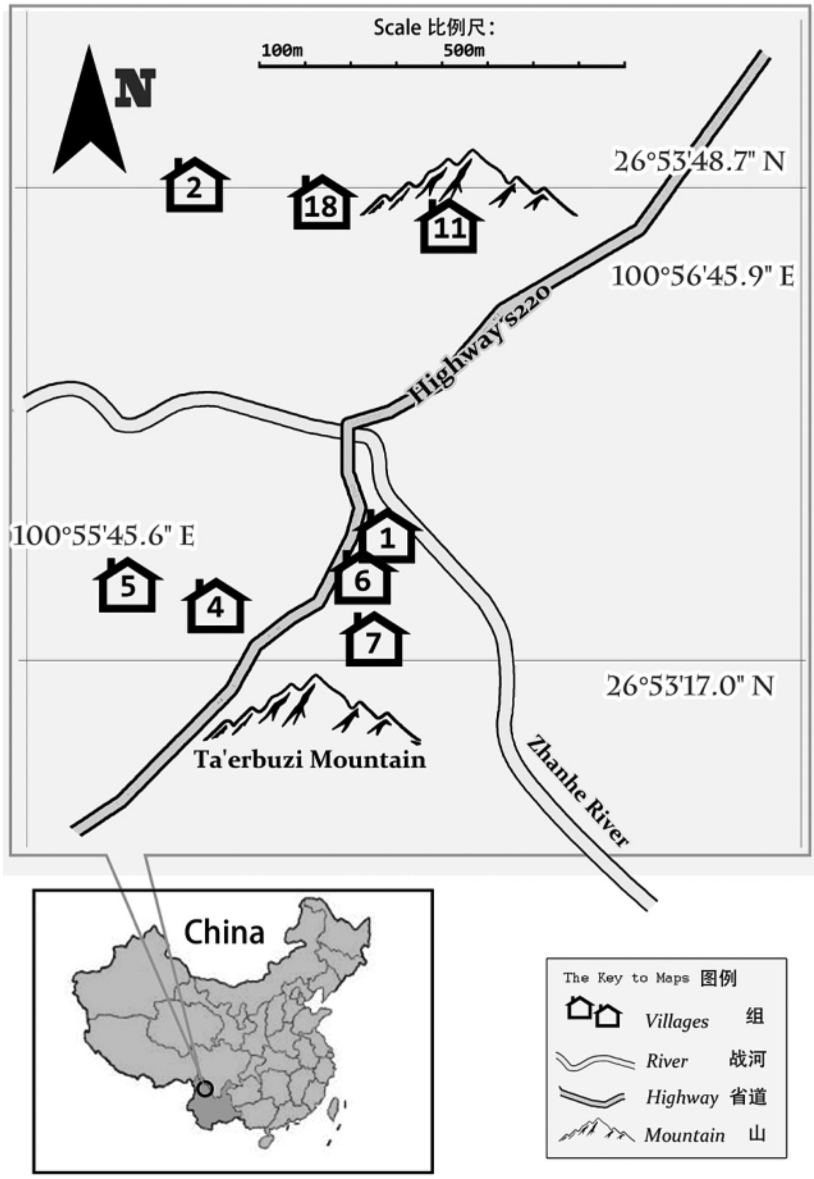

Figure 1. Map of study location: Zhanhe Township, Yunnan, China.

the extremely mountainous topography of this region, it is one of the most biodiverse temperate ecosystems in the world and it continues to sustain a culturally diverse population with a rich knowledge of the local ecosystem. However, the people who make their livelihoods in northwest Yunnan, mostly by subsistence farming, remain among the poorest in China. In a recent report on human development in China, Yunnan ranked among the lowest on provincial-level units (UNDP 2019), and Ninglang County (where the study site is located within) has been listed as an "impoverished county" by provincial government for years. Villagers struggle to make a cash income to educate their children and access other social services that were previously provided by the government before Reform and Opening (*Gaige kaifang*, 改革开放).

The exact location of this study was Zhanhe township, which is under Ninglang County's administration, 40 miles (64 km) south of the Ninglang County town. All residents in Zhanhe township belong to the Nuosu; Nuosu was classified as part of the Yi shortly after the establishment of the People's Republic of China. However, the Nuosu distinguish themselves from the Yi by languages, costume, and rituals. Zhanhe was an ideal site to conduct this study because many of its agricultural communities are in the middle of socioeconomic transition from small-scale subsistence farming to the production of cash crops and the pursuit of off-farm labor opportunities. Households currently face difficult decisions about cropping strategies, participation in market-based agriculture, and migration into cities and towns to improve their economic conditions, all of which pose challenges to local farmers' traditional knowledge of WEPs.

Zhanhe Township traditionally relied on a rich body of ecological knowledge and continues to rely almost exclusively on the production of subsistence crops, especially bitter buckwheat (*Fagopyrum tataricum*), potatoes (*Solanum* spp.), maize (*Zea* spp.), and oats (*Avena* spp.). The highest elevation is at 3980 meters (approximately 13,057 feet) and the lowest at 1800 meters (approximately 5905 feet). Zhanhe consists of 18 natural villages, which are the basic administrative unit of China, with a total number of 927 households (as of 2016) scattered across mountain valleys (Figure 2). Given its complex topography and high diversity of climates, there are numerous plant and animal species located in the township.

Ninglang Yi Autonomous Prefecture is recognized as a place of cultural significance, as it is home to multiple sociolinguistic groups, including Nuosu, Han, Tibetan, Naxi, Pumi, and others. Nuosu people account for about 63% of the total population of the county and have a rela-

Figure 2. Villages in Zhanhe Township.

tively well-preserved and distinct cultural identity.

In general, people living on the Qinghai-Tibet Plateau have a fairly limited range of domesticated food choices. The staple traditional diet for the Nuosu includes bitter buckwheat; archaeological evidence suggests this has been grown as a staple grain by highland groups, such as the Nuosu, Tibetan, and others in the Himalayan region, for at least 2000 years (Weisskopf and Fuller 2014). On the other hand, Nuosu people reside in high mountains, which gives them access to forests, where they collect WEPs for vital dietary support, livestock fodder, and cash income.

Ethnobotanical and ethnomycological studies have provided useful information on edible plants and fungi, diversity of use, and knowledge patterns in different parts of the world. However, academic work is limited with respect to factors affecting the distribution, reproduction, and transmission of knowledge of WEPs and fungi on a global scale due to the specific ecological, cultural, historical, and socio-economic contexts (Antweiler 1998). In China's case, there are several ethnobotanical studies concerning WEPs used by ethnic minorities, such as Mongolians, the Miao in Hunan province, and various ethnic minorities in Yunnan (Boesi 2014; Hong et al. 2015; Ju et al. 2013; Liu et al. 2012; Xu and Wilkes 2004; Zhang et al. 2004). The WEPs of the Xiao Liangshan region used by Nuosu people have not been systematically studied until this research, except for previous work carried out by Dr. Stevan Harrell (pers. comm., 2016) and his team. In the early 2000s, they documented plant species in the Da Liangshan (大凉山) area in Yanyuan of Sichuan Province with Nuosu people. However, the team produced an incomplete record of TEK related to local plants and most of the work remains unpublished.

The study site, Zhanhe township, is also undergoing a dramatic agricultural transition from subsistence farming to cash cropping led by local government officials aiming to build a massive walnut plantation, which introduces walnuts as a cash crop to eventually replace traditional crops completely. However, out of 18 natural villages in Zhanhe, only eight are included in this project. Therefore, this study is able to examine the dynamics of Zhanhe as its transformation is in progress and to compare two different types of villages (subsistence farming vs. cash cropping) regarding traditional knowledge of WEPs and fungi. Subsistence farming villages include village 4, 5, and 11; walnut villages include village 1, 6, 7, and 18 (see Figure 1).

Data Collection

The main fieldwork for this study was conducted by the first author between August 2015 and March 2016, plus two pilot studies—each lasting two months—during the summers of 2013 and 2014. The purpose of the pilot studies was to select research sites and gain general knowledge of the area's demography and socio-economic conditions, as well to make connections with the local government and residents. The first author had been put into contact with local government officials before conducting pilot studies through Yunnan Nationalities University (YNNU). Two professors in the department of Ethnic Cultures at YNNU provided help via personal network, connecting the first author with the local government officials. In 2013, local government officials had just made the plan to build the walnut plantation and gained support from and collaborated with the Agriculture and Forestry Bureau in Lijiang. Therefore, during the pilot studies, informal interviews, semi-structured interviews, and free lists were conducted to gain information regarding local farmers' attitudes toward introducing walnut planting and local farmers' knowledge of WEPs and fungi. Primary results show that Nuosu farmers in Zhanhe actively collect WEPs and fungi during summer, mainly from May to August, when the weather is warmer and has more rain. Those preliminary results laid the foundation for the main fieldwork.

Data collection methods involved in the main fieldwork proceeded as follows: First, local government officials of Zhanhe were consulted regarding local census data and farmers' agricultural livelihoods as a background of the study, along with basic background information on WEPs and fungi. Second, semi-structured interviews with 42 local Nuosu farmers were conducted by the first author and a local interpreter using convenience sampling. Third, based on the information gained from the semi-structured interviews, a survey instrument was distributed to 134 households based on a purposive sampling frame to get a balanced sample based on the gender and age of participants. The survey instrument included free-listing exercises regarding the names and uses of WEPs and fungi to understand the breadth of traditional knowledge in the community. Fourth, based on the data collected through free lists, semi-structured and informal interviews, and key informant interviews, a questionnaire (Table 3) containing 23 questions (true/false/I don't know options) related to the uses of WEPs and fungi was administered in seven natural villages with 58 participants, including 30 males and 28 females, based on the same purposive sampling frame, ranging in age from twenty to eighty-eight. Data were analyzed in UCINET (Borgatti et al. 2002) with the consensus analysis model, which uses a form of factor analysis. The consensus survey was designed based on the cultural model to understand the distribution of knowledge about WEPs and fungi in the study community. During the process of carrying out household surveys, the first author also conducted interviews with eight key informants who were identified by government officials and local farmers as particularly knowledgeable about the uses of wild edible plants and fungi.

Data Analysis

Fieldwork activities were conducted mostly in Nuosu language with the assistance of a local Nuosu interpreter, occasionally in the local dialect, in which the first author is fluent. Interviews were translated into Mandarin Chinese first by the interpreter, then translated into English by the first author. All interviews were analyzed using the software MAXQDA. Survey data were analyzed in SPSS, and the consensus data were analyzed using the software UCINET.

Consensus analysis (Romney et al. 1986) is considered both a theory and a method. As a theory, it specifies the conditions under which agreement among people can be seen as a sign of knowledge or "getting it right" within a particular cultural group. As a method, consensus analysis provides a way of conceptualizing and accounting for individual variability in knowledge within and between groups (Borgatti and Halgin 2011; Gatewood 2012). As D'Andrade (1987) suggested, "For a long time there has been a scandal at the heart of the study of culture. This scandal goes as follows: all human groups have a culture; culture is shared knowledge and belief; but when we study human groups, we find that there is considerable disagreement concerning most items of knowledge and belief." Building on this, consensus analysis provides a way of measuring how much of the agreed-upon set of cultural knowledge an individual has, which is referred to as "cultural competence." Within a group that has been determined to constitute a single culture and when asked questions within a particular domain, consensus analysis allows the researcher to ascertain the culturally correct answer to every question in a survey (Borgatti and Halgin 2011).

Consensus analysis allows the researcher to assess whether informants share a single cultural model of a domain (such as WEPs and fungi), and also to estimate the degree that individual views conform to the cultural model. In this sense, the method analyzes cultural knowledge both in the aggregate and at the individual level. To support the hypothesis that informants share a cultural model (what Borgatti [1994] has called the "one culture hypothesis"), three conditions must be met: 1) the ratio of the eigenvalue of the first and second factors should be 3 to 1 or higher; 2) a substantial amount of the variance should be explained by the first factor; and 3) all individual factor loadings on the first factor should be highly positive. If this is the case, then the first factor extracted represents the "average" knowledge of study participants and an individual participant's factor loading can be treated as his or her "agreement" or "competence" score with respect to the consensus model (Ross 2004).

Results

The Diversity and Multiple Uses of Wild Edible Plants (WEPs) and Fungi

The first research question guiding this study is: What are the categories and uses of WEPs that are most important for local farmers? The free-listing exercise elicited a total of 139 species of WEPs. The 139 species documented included widely different genera and species, including herbs (41.7%, 58 species) and fungi (28.1%, 39 species), which represented the greatest number of species. Local plant names in the Nuosu language are presented in the Chinese Pinyin phonetic system. Determination of scientific names was done in collaboration with regional taxonomists as part of a previously conducted ethnofloristic survey of the Nuosu (Stevan Harrell, pers. comm., April 2016). The average number of species mentioned per study participant was 13.4 (mean = 13.4, median = 14, SD = 5.531). In the language of Nuosu, the prefix and suffix of *mu* usually indicates a type of fungi, while the prefix of *si* usually indicates fruit and the word *vo* usually indicates herb.

In this study, in addition to edible uses, 74.8% of the recorded WEPs and fungi (104 species) have additional reported uses (Tables 1 and 2). Multiple use of species is common in rural areas and important to local people in terms of providing additional nutritional value to a starchy diet (compensating for the lack of several vitamins, proteins, and minerals), aiding medicinal

Table 1. Types of WEPs and fungi consumed by Nuosu people in Zhanhe.

Specific types	Number of plants
Vegetable	89
Spices	21
Fruit	20
Tea	5
Oil	4

Table 2. Different uses for WEPs and fungi in Zhanhe, Yunnan, China.

Types of uses	Number of species	Percentage
Edible	139	100.0
Fodder	46	33.1
Cash income	43	30.9
Medicinal	32	23.0
Ritual	6	4.3
Fuel-wood	4	2.9
Farming	4	2.9

purposes, providing natural fodder for livestock, and serving as a means of earning cash income (Etkin 2002; Shrestha and Dhillion 2006). Thirty-two species (23%) were reported to have medicinal values, most of them herbs (21 species). The medicinal plants are used to treat a variety of illnesses and symptoms, including cough, fever, rheumatism, fractures, dyspepsia, asthma, postpartum care, and high blood pressure. For instance, dandelions are traditionally stewed with pork by local people, and this dish is also purported to be good for kidney health.

WEPs and fungi provide resources and offer the potential for future investigation of new health and dietary products. Along with the potential for sustainable livelihood improvement in local communities, there is an increased demand for healthy and safe foods globally and there may be market potential for these resources both regionally and beyond (Glover 2007). Compared to conventionally cultivated food sources, WEPs and fungi have great value with respect to the way of growing and the nutritional significance. However, due to environmental changes, which are mostly caused by human activities, some WEPs are now difficult to collect and harvest. Informants mentioned in the interviews that while certain species were common decades ago, they are either not abundant in the forest anymore or are rarely seen.

In addition to the dietary and medicinal values of WEPs and fungi, the recorded ethno-species in Zhanhe also provide cash income for many households. In this study, the commercial value mostly comes from fungi. All fungi are collected in the forest of the nearby mountain by local people and traded or sold in local markets, which provides households with cash income. Of 39 ethno-species of mushrooms recorded in this study, *Boletus* spp. (牛肝菌) was the most frequently mentioned wild mushroom genus. In Zhanhe village, two common types of *Boletus* are commonly collected and commercialized, *Boletus edulis* (白牛肝菌) and *Boletus luridus* (见手青/红牛肝菌), which are added to soups or stir-fried with pork and garlic, usually cooked with high heat to get rid of toxic compounds. However, according to local farmers, destructive harvesting of wild mushrooms has become a significant concern and several species of wild mushrooms are reported as more and more difficult to find, including *Boletus edulis* (白牛肝菌), *Tricholoma matsutake* (松茸), and *Collybia albuminosa* (山鸡枞), which may indicate a trend of loss in biodiversity and cultural knowledge.

Consensus Analysis Approach to WEPs

The second research question guiding this paper is: Do members of the study community share a cultural model of TEK related to WEPs? This question was addressed by consensus analysis.

Questions used for collecting the consensus survey are listed in Table 3. Results indicated a good fit to the consensus model, with a largest eigenvalue of 29.110, second largest eigenvalue of 6.577, and a ratio (first factor to second factor) of 4.426, all of which provide strong evidence that Nuosu people in Zhanhe share a cultural model of WEPs and fungi (Table 4). The average competence score (range from 0–1) among 58 participants was 0.70. There are no negative competence scores or scores that are below 0.3, which would indicate a failure of consensus. As Borgatti and Halgin (2011) point out, the greater the competence score, the more likely their response is the "correct one"—in other words, the most widely agreed upon response.

However, within the domain of WEPs and fungi of Nuosu people in Zhanhe, variability exists in terms of individual competence. Competence variability (measured from 0 to 1) refers to the differences in responses within a given culture, which is to say among people for whom the same answer key applies. In any culture, some people simply know more of the cul-

Table 3. List of questions on other uses of WEPs and fungi (n = 58).

Topic/Question	Cultural Consensus on Correct Answer[a]
1 The white *hei ke* is useful to ease rheumatism pain	T
2 *bo bu ci ke* could be used to get rid of parasites	T
3 *bu ji* is helpful with rheumatism	T
4 *ai cao pu* only grows on high elevation and could be used to cure stomachache	T
5 *la zi cao* is a type of fodder for pigs	T
6 *nie zha* is a type of fodder for pigs	T
7 add garlic when cooking *bo hong*, if the color of garlic changes meaning the mushroom is poisonous	T
8 *ke si na ji* has therapeutic effect for hepatitis	T
9 *si da lan duo* could be used to graft pears	N/A
10 *vo mu die bu* is good for postpartum care	T
11 *su su* could be used to make vinegar	T
12 *ge bu lu fu* is used to treat headache	T
13 *ma bu* is good for relieving pain	T
14 *a nie si bu* is a type of pig fodder	T
15 *si mi* could be used as a type of pig fodder, soak it in water before feeding.	T
16 *pu gong ying* is good for kidney health, stew it with pork.	T
17 *vo mu ji ni* is a good type of tonic	T
18 *wu mu ke bu* is only edible to human beings, poisonous to pigs, chickens, and dogs.	T
19 *san qi wei* is good for curing coughing	T
20 *qi jiao* is good for curing coughing	T
21 *yi ni ka bu* is helpful with stomach illness	T
22 *si bu* is good for controlling high blood sugar	T
23 *wo mu ze ke* is good for kidney health	T

[a] The meaning of T=true; F=false; N/A=does not know.

turally correct answers than others do. For example, some people know the names of many different kinds of trees, while others know only a few, even when they belong to the same cultural groups (Borgatti and Halgin 2011). The highest competence score was 0.881 and belonged to an 83-year-old male participant, whereas the lowest competence score was 0.452 and belonged to a 20-year-old male participant.

Distribution of TEK According to Socio-Economic Variables

The third research question of this paper is: Does the distribution of TEK related to WEPs and fungi vary based on key demographic variables, including age, gender, travel time for collecting, and village location? As mentioned above, in general, competence varies among people within a culture

Table 4. Results of consensus analysis of questionnaire "Uses of WEPs," with true/false/I don't know (23 items).

Consensus	Eigenvalue	Ratio	Mean competence score	Min. competence score	Max. competence score	Std. Deviation
Yes	Lar. 29.110 2nd 6.577	4.426	0.70	0.452	0.881	0.107

and Nuosu people's knowledge about WEPs and fungi is no exception. The association between TEK related to WEPs and fungi and socioeconomic and demographic variables (including gender, age, economic status, and travel time for collecting), was analyzed in SPSS using Mann-Whitney U Test and Spearman's rho, respectively.

The Mann-Whitney U Test was used to analyze whether or not there was a statistically significant difference between males and females concerning the competence scores on WEPs and fungi and whether there was a significant difference between farmers who live in different villages with respect to their competence scores on WEPs and fungi. Residence location was tested as a key variable because the local government recently implemented an agricultural program aimed at transitioning local agriculture from subsistence farming to cash cropping by encouraging and assisting local farmers with walnut planting. Therefore, eight natural villages out of 18 have been included in the walnut plantation project since 2014, while the other ten villages remain excluded. Results show that there is no significant difference ($p > .05$) between males (N = 30) and females (N = 28), with a minimal effect size ($r_{pb} = .01$) (Vaske 2008) (Table 5). This could be due to the task distribution of local Nuosu, where the male tends to collect medicinal plants while the female is mainly responsible for collecting food resources.

Results show that there is no statistically significant difference ($p > .05$) between farmers who live in villages that are designated as part of the walnut plantation versus those who live in villages that are excluded from the project (Table 6). However, this may be an artifact of the sample size. There were 28 participants from walnut planting villages with an average competence score of 0.67 and 30 from non-walnut planting villages with a mean competence score of 0.73. Notably, the effect size ($r_{pb} = .24$) indicates the strength between two types of villages with regard to competence scores of WEPs and fungi is typical (Vaske 2008). People who live in walnut plantation villages tend to have lower competence scores than those who live in non-walnut planting villages. There are possible factors that contribute to this finding, including the access to markets and long distance from where the wild food resources are located for the informants who live in walnut plantation villages. This finding shows an interesting divide, even though the difference between two types of villages is not statistically significant. The effect size warrants further consideration, as the experimental villages had been under agricultural transition for only two years when the data were collected. Thus, these data may be early indications of a trend towards knowledge

Table 5. Mann-Whitney U Test results comparing male and female on competence scores on WEPs.

Gender[a]	N	Mean	Standardized Test Statistic	Sig.	Effect size (r_{pb})[b]
0	30	.69	.054	.957	.01
1	28	.70			

[a] Gender is coded as 0 = male, 1 = female; [b] r_{pb} = Point biserial correlation.

loss of WEPs. In qualitative interviews, farmers living in experimental villages consistently told the researcher:

> We don't collect those [wild edible plants] anymore. We used to when life was harsher decades ago, but now quality of life has been improved greatly, we go to the market and buy whatever vegetables are available. Nowadays, only people who live in deep mountains [*shankankan*, 山坎坎] would still go and collect those to help with household income.

Time spent on travel to collect WEPs in Zhanhe is basically determined by how the local government decided to include different villages in the walnut planting scheme. This provides a type of in situ experiment to examine the association between government policy and TEK about WEPs.

Spearman's rho was used to test the association between travel time for collecting and competence scores on WEPs and fungi. Participants from non-walnut villages (N = 30) spent on average 15–30 minutes traveling to collect WEPs and fungi, whereas participants from walnut plantation villages (N = 28) spent on average 2–4 hours walking to collect wild food resources. The results indicate no statistically significant difference (p = .069) between different travel times, which may be an artifact of sample size; however, the effect size (r_s = −.24) indicates the strength between travel times and competence related to WEPs and fungi is typical (Vaske 2008). The negative effect size indicates that people who spend less time on travel to collect WEPs tend to have higher competence scores. The finding on the correlation between travel time and farmers' WEP competence scores reflect the socio-economic reality of Zhanhe, although the finding is not quite statistically significant at the 0.05 level. One reason could be the relatively small sample size. However, it is clear that recent economic changes have affected everyone in the area. As one study participant, a 54-year-old woman who lives in a non-walnut planting village noted:

> Life's better than before. We didn't even have shoes even a few years ago; everyone, no matter elder or children, we all walked barefoot, went to the farmlands barefoot… I collect wild mushrooms for money, because they are expensive and a lot of people living in city like to eat them. It's lucky if I can pick some Matsutake because they are worth a lot of money, but they are really hard to find now. We barely have cash income; we live off what we cultivate.

Finally, Spearman's rho was used to investigate if there is a statistically significant difference among different ages in terms of the competence scores on WEPs. Results show that the correlation is statistically significant (two tailed $p < .001$) with a substantial effect size (r_{pb} = .65), indicating that age plays an important role in knowledge of WEPs in Nuosu people at Zhanhe (Vaske 2008). Figure 3 shows the positive correlation between age and competence scores; the older the participant is, the higher his or her competence score. It is potentially a realistic reflection of younger generations' inability to identify wild food resources and the trend of the younger generation moving away for jobs and opportunities. We also

Table 6. Mann-Whitney U Test results comparing two types of villages on competence scores of WEPs.

Village[a]	N	Mean	Standardized Test Statistic	Sig.	Effect size (r_{pb})[b]
0	28	.67	1.906	.057	.25
1	30	.73			

[a] village is coded as 0 = walnut plantation villages, 1 = not included in the walnut plantation project; [b] r_{pb} = Point biserial correlation.

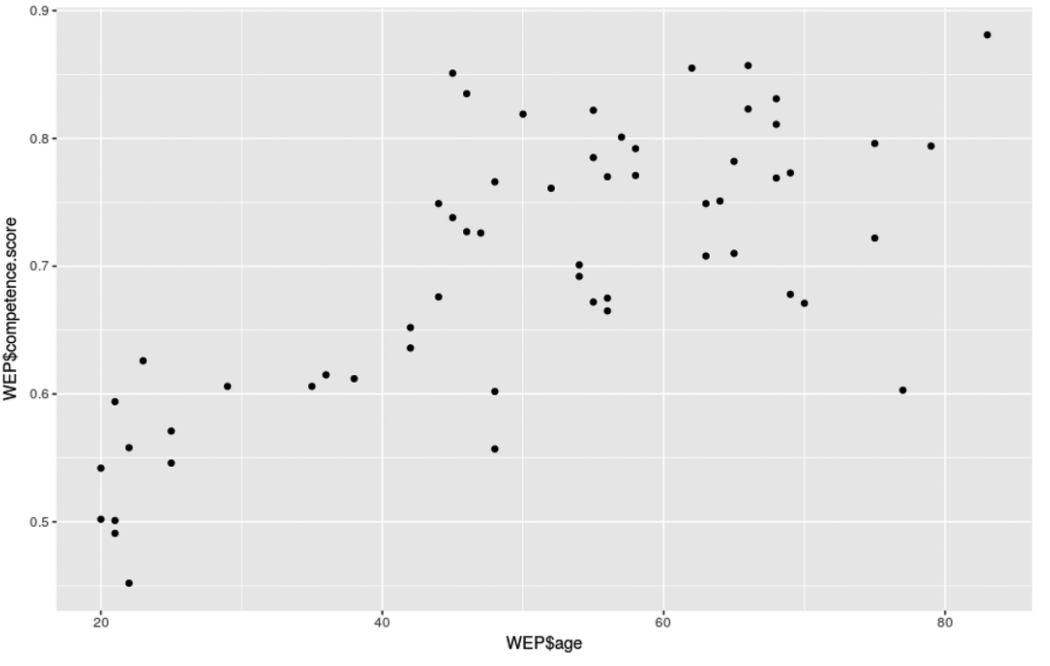

Figure 3. The correlation between age and competence score.

applied a one-way ANOVA to test if there was an age difference between the two types of villages; the results indicate that the correlation is not statistically significant (p = .660). However, we also need to take into account the sampling strategy that we attempted in order to balance the age distribution in the two types of villages, which could prevent us from capturing other facets of the phenomenon. As previous research showed, there are various implications when testing the correlation between age cohort and the traditional knowledge; for example, Godoy et al. (2009) found no cohort effect indicating that the association with age was because of life-time accumulation of knowledge. Therefore, although there is a great amount of research being conducted on this aspect, further investigation from a systematic approach is still needed.

Discussion

This study explores Yi people's traditional knowledge about WEPs in Zhanhe township located in Yunnan, Southwest China. The study further examines the correlation between acquired competence scores through consensus analysis and various demographic variables, including age, gender, residence in difference types of villages, and time spent on travel to collect WEPs.

Zhanhe encompasses an area of great biodiversity and 139 ethno-species of commonly used WEPs and fungi were recorded. This study also identified a significant overlap between WEPs and fungi used for various purposes, including food, medicine, and market sale. There are a great deal of studies addressing this overlap (Etkin 1994, 1996; Grivetti and Ogle 2000; Pieroni et al. 2002; Price 2006; Soukand et al. 2017; Stepp and Moerman 2001). However, as Pieroni and Quave (2006) point out, very little attention has been paid to the medicinal character associated with the consumption of WEPs from the local perspective.

Knowledge about the uses of WEPs and fungi was examined using consensus analysis, which indicated a good fit to the model and demonstrated that Nuosu people in Zhanhe share a basic common knowledge on WEPs and fungi. Furthermore, the results show that, concerning competence scores on WEPs, there are no significant differences between men and women. Situating this in the context of current literature, this finding differs from Voeks' (2007) study on women's traditional plant knowledge in Northeast Brazil, where the results indicated that women are more familiar with both the field identities and the medicinal values of the local flora than men. Turner (2003) also illustrates that gathering was the traditional work of women among Indigenous societies in North America. Similarly, Price and Ogle (2008) conclude that women are pivotal with respect to managing wild food plants, bringing these plants to the tables of their families, and to consumers through food preparation and marketing of WEPs in Southeast Asia. With many scholarly works focusing on women's predominance as gatherers in various societies across the globe, the pattern of women's dominant role as gatherers is not common in all contemporary societies. Camou-Guerrero et al. (2008) found that there are no significant differences between men and women in terms of overall knowledge of plant species in the Sierra Tarahumara of Mexico and Brandt et al. (2013) found in rural communities of Bolivia that gender plays a minor role on knowledge of Andean agro-forestry species. Research conducted by Goebel (2003) on Zimbabwean woodlands also illustrates that wild food plants gathering is not always women's work, as she points out the difference of wild food plants listed by men and women. Men commonly listed wild vegetables, while women listed other plants, such as medicinal herbs, in part because the forest is not considered as a women-friendly habitat.

The results also show that there is no statistical difference between different types of villages (those participating in traditional farming strategies vs. those practicing cash cropping) or between different travel times spent on collecting WEPs and fungi. However, the two variables (village type and travel time) show a typical to substantial correlation strength. Given the relatively small sample size of this study, effect size is reported because it is less influenced by the sample size (Cohen 1988; Vaske 2008). We propose a few explanations for this finding. Villages are still in the early stage of agricultural transition and the difference would likely be more apparent given a wider time span. This emphasizes the need for future longitudinal research in the area. Also, villages that are excluded from walnut planting share some common features, such as high elevation, steep terrain, inconvenient traffic conditions, and close proximity to the forests. This means, on one hand, that farmers who live there have easier access to wild food resources. On the other hand, such challenges also prevent them from participating in many economic development opportunities.

Age plays an important role in the acquisition of knowledge about WEPs and fungi. The older the study participant is, the higher his or her competence score. This supports the findings of Reyes-Garcia et al. (2006) that factors shown to influence the knowledge and use of natural resources include distribution of the natural resource, demographic characteristics, residence periods, and occupation. Unlike some classic studies on traditional knowledge and age, which focus more on tracing the transmission of certain traditional knowledge and culture to children (Hunn 2002; Setalaphruk and Price 2007), this study shares insights on how knowledge of WEPs is distributed among people of different ages and presents a picture of potential knowledge loss.

Narratives from younger generations illustrate the plight and reality of traditional knowledge about WEPs of the Nuosu people in Zhanhe. There is a trend that traditional knowledge is gradually changing due to social, economic, and ecological changes. The younger population moves to the cities for jobs, creating a disconnection from the natural environment, which directly causes the loss of traditional knowledge. Meanwhile, social changes happening at a rapid pace in China tend to dramatically alter the landscapes of rural regions by encouraging modern agriculture and monoculture.

The consensus analysis approach and the correlation analysis provide insights to examine TEK related to WEPs and fungi of Nuosu people. The decline of traditional knowledge among younger people is particularly a common trend. TEK evolves continuously adding lessons from the past to the present (Hunn 2002). The initial acquisition of knowledge happens through innovation or diffusion (Weisskopf and Fuller 2014). If a region is isolated or remote with long distances to markets and forest product substitutes, the learning of TEK is a necessity (Nesheim et al. 2006). As indicated in the study, the people who reside in non-experimental villages share higher competence scores and they often note that they collect WEPs out of necessity because of their isolation. Knowledge that is maintained, transferred, or exchanged tends to have a specific value that is essential for subsistence (Benz et al. 2000; Nesheim et al. 2006; Turreira-Garcia et al. 2015). Local knowledge depends on social transmission, through the family or collectively within a community (Ladio and Lozada 2001; Zarger and Stepp 2004). Out-migration creates a chasm for knowledge transmission. The loss or erosion of TEK is often due to changes in social relationships (Ross 2002), access to new products (Gadgil and Berkes 1991), or exhaustion of the resource (Dweba and Mearns 2011; Ladio 2001). Economic activities that are not related to the local environment tend to negatively affect ecological knowledge (Reyes-Garcia et al. 2006).

Further research, particularly longitudinal research involving a full flora inventory, is needed in order to fully comprehend the factors that contribute to the declining trend of traditional knowledge about WEPs among Nuosu people in Zhanhe, and to complete the scientific information of the collected wild food species. It is possible that traditional knowledge of WEPs is declining in response to the introduction of cash crop agriculture, but further longitudinal research is necessary in order to answer this question. Additional studies are also required to test the practical knowledge of local farmers to examine if there is a gap with their theoretical knowledge and to track changes in knowledge transmission among villages inside and outside of the walnut plantation.

Limitations of the Study

There are two dimensions of ethnobotanical knowledge, including theoretical and practical knowledge. Theoretical knowledge refers to the ability to name plants, whereas practical knowledge refers to the skillsets to put the knowledge into practice or to identify organisms based on names (Godoy et al. 2005; Reyes-Garcia et al. 2007). In this case study, practical knowledge was not tested because field research took place during the off-season. Study participants indicated that WEPs and fungi are mainly collected during the summer months of June, July, and August. The major part of this fieldwork was conducted between August 2015 to March 2016. For this reason, the practical knowledge of WEPs awaits further investigation.

Another limitation of this study lies in the complicated and diverse intercultural differences in China. While there are 55 ethnic minority groups officially recognized by China's central government, the actual number is likely in the hundreds (Mullaney 2010). Yi people are the seventh largest of the 55 recognized groups, numbering approximately eight million. The population is widely distributed in different provinces across China, including Yunnan, Guizhou, and Sichuan. There are six Yi languages recognized by the Chinese government, with only 25% to 50% of vocabulary in common. Among the six Yi languages, Nuosu (诺苏) is the dominant one, also known as Northern Yi, Liangshan Yi, and Sichuan Yi, which is held by the Chinese government to be the standard Yi language (Zhu et al. 2004). The population of this study is Nuosu, but has a slight difference with the Nuosu who are living in Da Liangshan (大凉山) region of Sichuan. As Chen (2010) points out, there are at least four types of dialects even within Nuosu language, including Senza, Yinuo, Lidim, and Sodi. This linguistic complexity posed significant challenges to this study in terms of translating the local names of WEPs to Mandarin and to Latin scientific names, which means that considerable work remains to confirm and verify some of these species.

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