Cultural Erosion of Balinese Indigenous Knowledge of Food and Nutraceutical Plants[1]

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Cultural Erosion of Balinese Indigenous Knowledge of Food and Nutraceutical Plants. The island of Bali has several traditional *Aga* villages that survive under the pressures of an intense tourist industry and agricultural changes. In order to understand possible impacts on traditional ethnobotanical knowledge (TEK) in Bali, we interviewed local people living in 13 traditional villages regarding the number of known plants and their uses. We analyzed socioeconomic factors influencing change of such knowledge at both individual (informant) and community (village) level. We identified a total of 149 food and nutraceutical plants being used in the study area. Neither gender, occupation, income, nor level of formal education had a significant effect on TEK. However, informant's age and village status were found to play an important role in the retention of TEK at an individual level. At the village level, the use of Internet/smart phones was an important predictor of cultural erosion.

Erosi Budaya Pengetahuan Adat Bali Tentang Tanaman Pangan dan Nutraceutical. Pulau Bali memiliki beberapa desa *Aga* tradisional yang masih bertahan di tengah tekanan pariwisata dan perubahan sistem pertanian yang signifikan. Untuk memahami kemungkinan dampak pada pengetahuan etnobotani tradisional (TEK) di Bali, kami mewawancarai penduduk lokal yang tinggal di tiga belas desa tradisional tentang jumlah dan kegunaan tanaman yang mereka ketahui. Kami menganalisis faktor-faktor sosial ekonomi yang mempengaruhi perubahan pengetahuan etnobotani di tingkat individu (informan) dan masyarakat (desa). Kami mengidentifikasi total 149 tanaman pangan dan nutraceutical yang digunakan di lokasi penelitian. Baik jenis kelamin, pekerjaan, pendapatan, atau tingkat pendidikan formal memiliki dampak yang signifikan terhadap TEK. Namun, usia informan dan status desa memainkan peran penting dalam mempertahankan TEK pada tingkat individu. Dan di tingkat desa, penggunaan internet/ponsel pintar merupakan prediktor penting dari erosi budaya.

Key Words: Cultural erosion, ethnobotany, food, nutraceutical plants, Bali *Aga* village.

Introduction

Indigenous societies are in general more aware of the importance of natural resources, and hence are less likely to abuse them, than non-indigenous societies (Benz et al. 2000; McNeeley et al. 1990; Williams and Baines 1993). However, folk knowledge of natural resources is now seriously threatened

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by globalization. Traditional Ethnobotanical Knowledge (TEK) is especially threatened in tropical areas, where single indigenous individuals and entire communities are rapidly changing their culture under the influence of Western models (Brosi et al. 2007; Quinlan and Quinlan 2007; Voeks 2010). Consumerism, religious conversion, access to Western lifestyles, and formal education have been identified as the most important factors responsible for TEK decline (Steinberg 2002; Voeks and Nyawa 2006). At the same time, loss of TEK is considered a major threat to the conservation of biological diversity (Ju et al. 2013; Keller et al. 2005). Even isolated areas such as tropical islands, once very difficult to reach for mass tourism, are now experiencing cultural erosion due to globalization, with the younger generations being particularly at risk (Scheyvens 1999; Voeks 2010; Williams 1998). Thus, documentation and evaluation of TEK, carried out through ethnobotanical studies, are urgently needed to preserve biological and cultural diversity (Guarrera and Savo 2013; Heywood et al. 2007; Ju et al. 2013).

Since the 1970s, the once remote Indonesian island of Bali has become one of the world's leading tourist destinations (Leurs 2010), and therefore represents a particularly well-suited model to study the influence of recent Westernization on TEK. In spite of severe pressures represented by the tourist industry, significant population increase, and technological changes in agricultural practices (Agung 2005; Leurs 2010), Bali Island still maintains many traditional indigenous villages, making it possible to investigate if and how globalization is affecting TEK.

In this paper, we investigated the influence of cultural changes due to globalization on a particular aspect of TEK—the indigenous knowledge of food and nutraceutical plants. For this, we used a twofold approach based on interviews with local people. First, we used variables describing the major socioeconomic characteristics of interviewed people to identify which globalizing factors influence TEK at an individual level. Second, we used village characteristics expressing globalization intensity to assess how globalization may influence change of TEK at the community level.

Materials and Methods

Research Area

Bali is located at the westernmost end of the Lesser Sunda Islands (Indonesia), between Java to the west and Lombok to the east (8°39'S115°13'E). Bali's climate is sub-humid, with yearly mean temperatures of 31°C. The rainy season occurs between November and April, whereas the dry season is between May and October (Badan Pusat Statistik 2013). The island has a surface area of 5,577 km^2.

We selected thirteen *Aga* (traditional) villages inhabited by families who have lived in Bali for many generations, and are therefore representative of the island's TEK (Astuti et al. 2000) (Fig. 1). These villages are located between 242 and 1,187 m above sea level, and at 45–80 km from Denpasar, the capital of Bali.

Most villages are surrounded by hills that have undergone significant deforestation. *Aga* villages are typically composed of 2,000 to 5,000 inhabitants, and livelihood strategies are mostly based on farming. Income is generated by selling agricultural products such as green vegetables, fruits, beans, and rice, which is used as staple food. The economic status of Balinese people can be classified as poor (less than USD 200) to medium (ranged between USD 200–1,000). To improve their economic situation, younger people tend to work in the capital city; therefore, most people remaining in the village are children, the middle-aged, and the elderly. Most villagers have received at least an elementary education. The younger generations have usually attended high school (medium education), but only a few studied at university (high education) (Badan Pusat Statistik 2013).

Ethnobotanical Data Collection

Fieldwork was conducted from May to July 2013. Information on the use of food and nutraceutical plants was obtained through interviews. A total of 50 informants ranging in age from 14 to 78 were selected via the snowball method (Bernard 2002). At least four informants per village were interviewed, and we tried to evenly cover males and females, younger and older people (Stepp 2004; Voeks 2004). Informants were asked to determine how familiar they were with food and nutraceutical plants and their respective values. Interviewees were made aware of the scope of this study and prior informed consent was requested verbally. Interviews were conducted following the ethical recommendations presented in Rosenthal (2006). Plants were collected together with the informants and then identified with the assistance of experts at the Bali Botanical Garden. Voucher

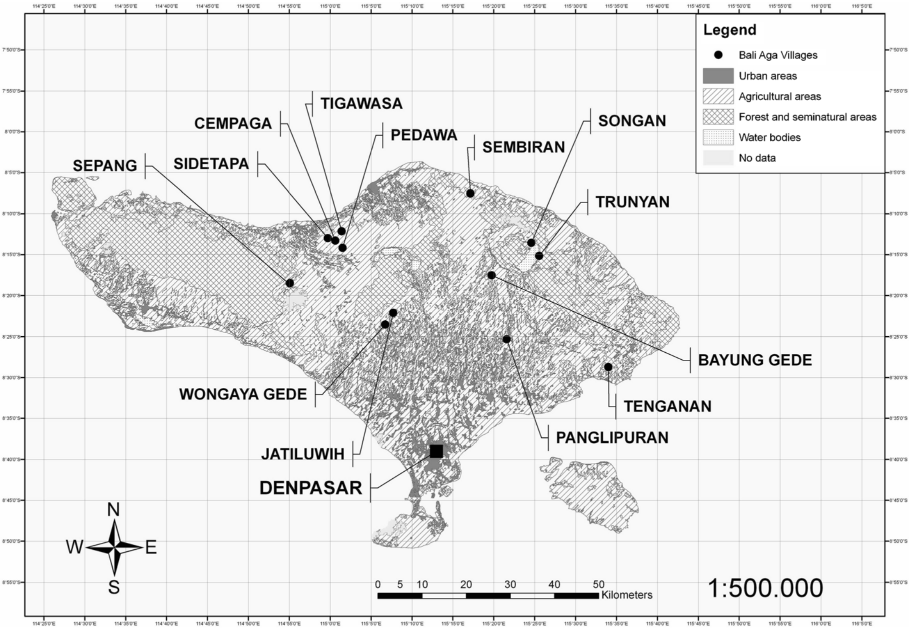

Fig. 1. Map of Bali Island (Indonesia) showing location of the 13 investigated *Aga* (traditional) villages.

specimens were deposited at the Herbarium Hortus Botanicus Baliense.

All detailed information on food and nutraceutical uses was first recorded as freely given by informants and then coded into the following six food and nutraceutical use categories: (1) vegetables, (2) edible fruits, (3) staple foods, (4) spices, (5) edible seeds, and (6) herbal drinks. The same plant could fall into more than one use category. Participants were also asked about the following socioeconomic features: (1) age, (2) gender, (3) education level (coded into the following four categories: no education, low education, medium education, high education), (4) occupation (coded into the following five categories: civil servant, farmer, religious leader, village official, and other), (5) monetary earnings, and (6) who had taught them about edible and medicinal resources (Table 1).

As younger people are in general believed to be more susceptible to globalizing influences, we divided participants into "younger people" (≤45 year old; 15 participants, 30% of sample size) and "older people" (≥46 year old; 35 participants, 70% of sample size). We used this age categorization because Bali has experienced profound socioeconomic changes, especially in the last 45 years (Agung 2005).

With reference to Badan Pusat Statistik (2013), we recorded the following geographical variables for each village as possible factors affecting TEK at the community level: (1) elevation, (2) minimum geographic distance to the nearest village, and (3) minimum geographic distance to the capital city. On the basis of Agung's (2005) description of recent

Table 1. Informant demographic data.

	n	%
Age		
≤ 45	15	30
≥ 46	35	70
Gender		
Men	45	90
Woman	5	10
Education		
No education (unschooled)	2	4
Low education (elementary)	16	32
Medium education (high school)	26	52
High education (bachelor)	6	12
Occupation		
Civil servants	3	6
Farmers	13	26
Religious leaders	14	28
Village officials	15	30
Others	5	10
Monetary earning		
Poor (< USD 200)	22	44
Medium (USD 200–1,000)	28	56
High (> USD 1,000)	0	0

socioeconomic transformations in Bali, we also considered the following variables that might express the influence of globalization on TEK: (4) number of shops (which is a measure of the incidence of modern economy), (5) percent of total villagers using Internet/smart phones (used as measure of globalization: globalization index 1–GI 1), and (6) percent of total villagers consuming "junk food" such as fried fast food and hamburgers (also used as an additional measure of globalization: globalization index 2–GI 2) (Table 2).

Statistical Analyses

Factors Affecting Variation in TEK among Informants

In ethnobotanical research, the degree of practical knowledge of plant resources is usually defined as the number of species and plant uses mentioned at the time of the interview (Caneva et al. 2013; Hoffman and Gallaher 2007; Signorini et al. 2009). In addition to these two basic indices, we used Shannon entropy, Simpson dominance, and Pielou equitability. These indices can be applied to various subjects, and are widely used in community ecology to quantify how individuals are distributed among species (Magurran 1988, 2003). In our context, these indices express how uses are distributed among species by capturing different aspects of knowledge diversity.

Shannon entropy, which has previously been used in ethnobotanical research (Begossi 1996; Reyes-García et al. 2007), was calculated as

$$H = -\sum \frac{n_i}{n} \ln\left(\frac{n_i}{n}\right)$$

where n_i was the number of uses of plant species (taxon) i, and n was the total number of uses of all taxa. H varies from 0 for an interviewee knowing only a single use, to higher values for informants when they are aware of many taxa, each with a similar number of uses.

Simpson dominance was calculated as:

$$D = \sum \left(\frac{n_i}{n}\right)^2$$

D ranges from 0 (all uses are equally present) to 1 (one use dominates the total botanical knowledge). Finally, Pielou equitability was calculated as: $J = H/\ln S$, where H was Shannon entropy and S was the number of taxa.

All these indices were considered as alternative measures of individual TEK. To identify which factors can be responsible for variation among individuals, multi-factorial analysis of variance (ANOVA) was adopted using the aforementioned socioeconomic variables (Table 1) as factors. The large number of factors included in the ANOVAs would generate an exaggerated number of

Table 2. Geographical and socioeconomic characteristics of the investigated Bali *Aga* villages. masl: meters above sea level; D. nearest village: distance to the nearest village (km); D. capital city: distance to the capital city of Bali Island (km); N. trad. shops: number of traditional shops; GI 1: globalization index 1: Internet/smart phone users (% of total villagers); GI 2: globalization index 2: junk food consumption (% of total villagers); N. plants: number of known plants; N. uses: number of uses.

No	Village name	Elevation (masl)	D. nearest village (km)	D. capital city (km)	N. trad. shops	GI 1	GI 2	N. plants	N. uses
1	Bayung gede	1097	1	65	20	25	5	33	42
2	Cempaga	752	1	76	15	25	5	47	53
3	Jatiluwih	610	1	50	20	40	10	35	42
4	Pedawa	748	1	75	16	25	5	38	44
5	Penglipuran	700	1	45	24	35	10	42	54
6	Sidetapa	403	1	77	22	35	5	43	52
7	Sembiran	408	1	80	18	40	10	28	32
8	Sepang	635	5	80	18	20	5	52	64
9	Songan	1134	1	75	22	40	10	24	33
10	Tenganan	242	1	55	20	40	10	47	53
11	Tigawasa	579	1	75	20	40	10	55	62
12	Trunyan	1187	2	75	8	20	5	43	57
13	Wongaya gede	756	1	45	20	40	10	37	48

interactions. So, we initially performed one-way ANOVAs without interaction terms to identify significant factors, which were then retained for a new set of ANOVAs, where interactions were considered. Diversity indices were calculated using the software PAST v.3 (Hammer et al. 2001). ANOVAs were conducted using the software Statistica v. 7.0 (StatSoft 2004).

Factors Affecting Variation in TEK among Villages

To express village-level TEK, we calculated the mean values of individual knowledge (diversity indices) from informants living in the same village. Since the aforementioned analyses revealed that age (and village) had a significant effect on individual TEK, we calculated, for each village, mean values of diversity indices separately for older and younger people. To investigate the role of geographical and socioeconomic factors in determining variations in village TEK, we constructed multiple linear regressions using the variables reported in Table 2 as possible predictors. For each diversity index we considered all possible combinations of these possible predictors and selected the OLS model with the lowest corrected Akaike information criterion (AICc) value as the best fitting model. For these analyses the software SAM 4.0 was used (Rangel et al. 2010).

Results and Discussion

TEK Transmission

Most interviewed people worked as village officials (15, i.e. 30% of all participants), religious leaders (14, 28%), or farmers (13, 26%). With regard to the educational level of participants, 2 (4%) had no education (unschooled), 16 (32%) had only an elementary-school education, 26 (52%) had gone to high school, and 6 (12%) had a university degree. Twenty-two participants (44%) had monthly earning of less than USD 200, and 28 (56%) ranged between USD 200 and 1,000. Male respondents were far more numerous than females, which might lead to the false conclusion that males are the main conduits of traditions about plant uses. In fact, the low number of females in our sample size is a reflection of predominant male role in Bali's traditional culture, especially in rural areas. Because males tend to dominate all aspects of daily life, women tend to be less confident in providing information. This sort of female shyness might be also enhanced because the interviewer was a male.

Although women were reluctant to provide information, it is likely that they maintain levels of TEK similar to, or even superior than, those of men, because it is the women that usually take care of preparing food for the family (Astuti et al. 2000). When we asked our informants who had taught them about edible and medicinal resources, the most frequent response (64%) was family members (mother, father, grandmother, and grandfather), as reported elsewhere for transmission of knowledge of wild plants (e.g. Lozada et al. 2006; Ohmagari and Berkes 1997).

Respondents reported in particular that their parents had learned about edible and medicinal plants only from within their own family circle. This lack of interfamily transmission may explain why our informants knew, on average, only about 30 plants (mean value ± SD: 28.90 ±7.32), in spite of the overall high total number of known plants (149 species). However, each informant knew most of the plants used by his/her village, and in some cases informant knowledge was very high (e.g., more than 39 plants per person in the village of Sepang). This suggests a relatively good level of efficiency of family transmission and is consistent with the central role exerted by the family, not only in the acquisition of behaviors, attitudes, or technologies, but also in the understanding of natural resources (Cavalli-Sforza et al. 1982; Lozada et al. 2006).

Plant Uses

For the 149 plant species recognized as having important practical applications in the Bali *Aga* culture, we recorded 1,777 citations (Electronic Supplementary Material–ESM) and 6 different primary use categories. The most relevant uses were as vegetables, herbal drinks, and fresh fruits (Fig. 2).

Fruits are often eaten fresh, while green leafy vegetative parts (e.g., leaves, young leaves, leaf tips, stems) are usually boiled, cooked, or added to soups, and less commonly used fresh in salads. All these parts are used as ingredients for *lawar* (mixed vegetables), which is a very popular food among the Balinese. *Colocasia esculenta* (L.) Schott, *Artocarpus heterophyllus* Lmk, *Piper betle* L., and *Zingiber purpureum* Roxb. are the most frequently used vegetables. Edible plants play an important role in providing the inhabitants of Bali with various essential nutrients, such as vitamins and minerals needed

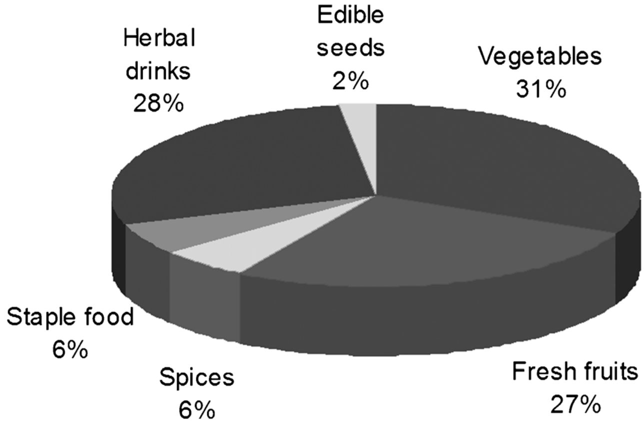

Fig. 2. Uses of plants of ethnobotanical interest in Bali *Aga* villages.

to maintain health and improve immunity to diseases (Ju et al. 2013).

Herbal drink plants are used for 30 types of diseases. For example, the decoction of leaves of *Cinnamomum burmanni* Nees ex Bl. is used to treat heartburn, fever, cough, sore throat, hypertension, and to stimulate the appetite. Most of the species are used to treat heartburn, fever, diarrhea, cough, hypertension, celiac disease, rheumatism, and urolithiasis. Based on the frequency recorded during this study, the most preferred tree and shrub species for herbal drinks are *Alstonia scholaris* (L.) R.Br., *Cinnamomum burmanni*, *Hibiscus tiliaceus* L., *Spondias pinnata* (L.f.) Kurz, *Azadirachta indica* A. Juss., *Andrographis paniculata* (Burm.f.) Nees, *Blumea balsamifera* (L.) DC., and *Orthosiphon aristatus* (Bl.) Miq. Among climber species, *Piper betle*, *Cyclea barbata* Miers, *Dolichos lablab* L., and *Paederia scandens* (Lour.) Merr. are preferred, whereas the most commonly used herbs are *Centella asiatica* (L.) Urb. and *Zingiber officinale* Roxb.

In general, herbal drinks are still preferred to modern medicines because they are cheaper, easily available, and self-administered. However, younger generations are shifting towards the use of modern medicines (Leurs 2010).

Indications of TEK Decline

The average number of plant species per village (mean value ± SD: 28.4 ±8.1) was substantially lower than the total number of plants using in all the villages. This suggests that, given the very small distances between villages (minimum intervillage distances ranged from one to five km), that a strong fragmentation of TEK has occurred. The TEK that people actually retain in many instances is much lower than the potential TEK that would be expected.

Figure 3 explores this question by showing average levels of knowledge for people, divided into two age classes, and for villages. Younger people contribute substantially to the total number of known plants only in villages with a higher number of known plants, whereas their contribution is much smaller in villages where the number of known plants is lower. In villages with a very low number of plants, all TEK is associated with older people. This suggests that an overall decline in TEK is occurring, and that it is concentrated in the younger generation.

On the basis of the median number of known plants per village (42), villages can be placed into four groups. The first group (highest quartile) is that of villages where more than 47 plants were recorded, and included Tigawasa and Sepang. The second group included the villages of Cempaga, Tenganan, Sidetapa, Trunyan, and Penglipuran, where the number of known plants was between 42 and 47. The third group (35 to 41 known plants) included the villages of Pedawa, Wongaya Gede, and Jatiluwih. Finally, the fourth group (lower quartile) included the villages of Bayung Gede, Sembiran, and Songan, where less than 34 plants are known. On the basis of discussions with local inhabitants, villages in the first and second groups are characterized by a considerable degree of social cohesion, such as the preservation of collective youth activities, *adat* law enforcement, and good communication between older and younger generations. By contrast, villages in the third and fourth groups appear to be in the grips of major socioeconomic

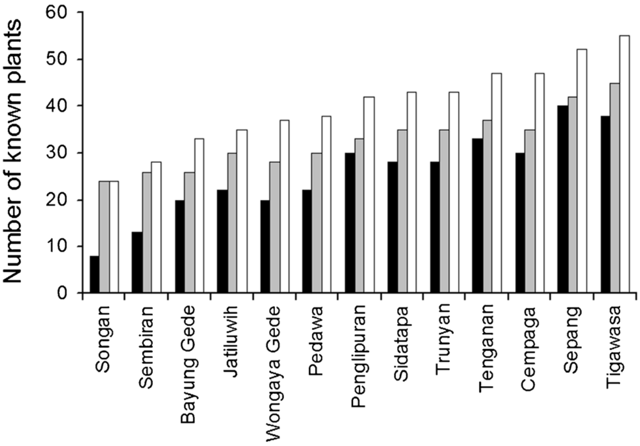

Fig. 3. Number of known plants in Bali *Aga* villages. Black bars: number of plants known by younger (≤45 year old) people; grey bars: number of plants known by older (≥46 year old) people; white bars: total number of plants known in a village.

changes, such as the migration of younger generations in search of jobs, the presence of monoculture crops, tourism, and globalization. Sembiran and Songan were the villages with the lowest diversity and the highest dominance in TEK values. These two villages are characterized by the presence of important new income sources, such as sand mining and monoculture cash crops (in Songan), or the acquisition of a higher education (in Sembiran), which leads to a certain unwillingness to remain in the native village.

Factors Affecting Variations in TEK among People

ANOVAs without interaction terms consistently identified native village and age of informant as the only significant factors affecting TEK. No other characteristic—gender, occupation, earning, and instruction—had a significant effect on informant TEK. On the basis of these results, we performed ANOVAs including native village and age, and their interaction, as factors. Interaction was significant for both Shannon entropy and Simpson dominance, which indicates that native village and age had a combined effect on these measures of TEK (Table 3).

Overall, our results indicate that age influences TEK, with older people knowing more species and more uses than younger people. Moreover, older people had higher diversity (Shannon's entropy), lower dominance (Simpson index), but also lower equitability (Pielou equitability). These results indicate that older people know a wider spectrum of plant uses per plant species (high diversity and low dominance), although some uses tend to be concentrated in certain plant species (low equitability).

Thus, our study supports the observation that TEK tends to be positively associated with the age of participants (Begossi et al. 2002; Bernstein et al. 1997; Phillips and Gentry 1993; Voeks and Leony 2004).

Although level of formal education varies considerably among participants, results from ANOVAs indicate that this factor has no significant effect on TEK. Similarly, TEK was not affected by gender. Women were generally reluctant to be interviewed, but those who agreed exhibited a level of TEK similar to that of men. However, this result should be considered provisional because of the small number of interviewed women.

Factors Affecting Variations in TEK among Villages

With regard to older people (Table 4), model selection based on AICc values identified village elevation as an important factor having a negative effect on TEK. In particular, elevation decreases ethnobotanical diversity and equitability (negative correlation) and increases dominance (positive correlation). Number of Internet/smart phone users (GI 1), which involved 20–40% of the total villagers, also had a negative effect in all cases, except for the number of known plants and equitability, and for dominance (where a positive correlation means a negative effect on TEK). Thus, in general, elevation and globalization (expressed by GI 1)

Table 3. Effects of socioeconomic variables on individual ethnobotanical knowledge. ANOVAs results for significant factors and their interaction: Np = number of known species; Nu = number known uses; H = Shannon index of diversity; D = Simpson index of dominance; J = Pielou index of equitability. SS = Sum of Squares; MS = Mean Square; F = Fisher F; p = probability. In all analyses, df are as follows: village =12, age =1, interaction =12, error =24, total =49.

	Np				Nu			
Factor	SS	MS	F	p	SS	MS	F	p
Village	2075.23	172.936	23.209	< 0.0001	2891.235	240.936	19.707	< 0.0001
Age	198.050	198.050	26.579	< 0.0001	282.069	282.069	23.072	< 0.0001
Village*Age	115.896	9.658	1.296	0.283	246.544	20.545	1.681	0.135
Error	178.830	7.450			293.420	12.230		
Total	2622.500				3744.420			
	H				D			
Factor	SS	MS	F	p	SS	MS	F	p
Village	3.383	0.282	25.792	< 0.0001	0.011	0.001	38.113	< 0.0001
Age	0.378	0.378	34.574	< 0.0001	0.001	0.001	55.298	< 0.0001
Village*Age	0.454	0.038	3.463	0.005	0.003	0.000	10.960	< 0.0001
Error	0.262	0.011			0.001	0.000		
Total	4.082				0.013			
	J							
Factor	SS	MS	F	p				
Village	0.001	0.000	11.088	< 0.0001				
Age	0.000	0.000	1.211	0.282				
Village*Age	0.000	0.000	0.548	0.861				
Error	0.000	0.000						
Total	0.001							

reduce TEK in older people. Junk food consumption (GI 2) was not recovered as an important factor, probably because of the low number of people that consume junk food, only 5–10% of villagers.

Results obtained for younger people are similar to those achieved for older people (Table 5). Again, increasing elevation had a negative effect on TEK. This is shown by the fact that elevation decreases TEK diversity and equitability (negative correlation) and increases dominance (positive correlation). Our indicator of globalization GI 1 had a negative effect in all cases, except for number of known plants and equitability, and for dominance (where a positive effect is consistent with a negative effect on diversity). Interestingly, for younger people, distance to the nearest village was indicated as an important factor enhancing the number of known uses (thus inter-village proximity promotes TEK), whereas distance to the main town increased dominance (thus, proximity to the main town reduces TEK by emphasizing uses connected to a smaller number of plant species).

The emerging overall pattern is that increasing elevation and degree of globalization has a negative effect on TEK (Reyes-García et al. 2005; Whitten et al. 1996). People living in Balinese villages at higher altitudes (>1,200 masl) may have access to a smaller number of potentially useful plants (Whitten et al. 1996). By contrast, the influence of globalization, measured as the percentage of total villagers using Internet/smart phones (G1), is a reflection of socioeconomic changes introduced by modernization.

Examination of standardized effects (ß weights) in multiple regression models suggests that the globalization indicator GI 1 has a slightly higher effect on younger than older people. Moreover, for all indices except Pielou equitability, regression models had a higher goodness-of-fit when applied to younger people as opposed to the older. These results, coupled with the fact that age was identified as a significant factor affecting participant's TEK, supports the idea that loss of knowledge at a community (village) level involves both older and younger people, but it is more pronounced in younger people.

The simplest explanation for this is precisely that offered by the participants in the study— older people retain part of the folk knowledge that had critical survival value in the past, but which is of little practical benefit or intellectual interest to the

Table 4. EFFECTS OF GEOGRAPHIC AND SOCIOECONOMIC VARIABLES ON VILLAGE ETHNOBOTANICAL KNOWLEDGE FOR OLDER PEOPLE. PARAMETER VALUES, STANDARD ERRORS, AND ASSOCIATED PROBABILITY LEVELS OF OLS BEST FIT MODELS FOR NUMBER OF KNOWN PLANTS (NP: R^2 =0.161, AICC =91.638); NUMBER KNOWN USES (NU: R^2 =0.087, AICC =96.011); SHANNON INDEX OF DIVERSITY (H : R^2 =0.462, AICC =1.414); SIMPSON INDEX OF DOMINANCE (D: R^2 =0.503, AICC = -82.562); PIELOU INDEX OF EQUITABILITY (J: R^2 =0.327, AICC = -101.35). GI1 = GLOBALIZATION INDEX 1; SE = STANDARD ERROR; ß = STANDARDIZED COEFFICIENT; T = STUDENT'S T.

	Np					Nu			
	Coefficient	ß	SE	t		Coefficient	ß	SE	t
Constant	37.244		4.886	7.623	Constant	46.316		8.837	5.241
Elevation	-0.009	-0.401	0.006	-1.453	GI1	-26.867	-0.295	26.259	-1.023
	H					D			
	Coefficient	ß	SE	t		Coefficient	ß	SE	t
Constant	4.215		0.321	13.125	Constant	0.001		0.013	0.104
Elevation	<.001	-0.718	<.001	-2.748	Elevation	<.001	0.748	<0.001	2.976
GI1	-1.504	-0.569	0.691	-2.176	GI1	0.065	0.595	0.027	2.368
	J								
	Coefficient	ß	SE	t					
Constant	0.989		0.003	338.791					
Elevation	<.001	-0.572	<0.001	-2.311					

younger generation. The much-used simile that "the death of each elder is like burning a book on traditional knowledge" seems quite appropriate here (Voeks and Leony 2004).

REASONS FOR TEK DECLINE

The recent arrival of ecotourism to some Bali *Aga* villages (Songan, Jatiluwih, Bayung Gede, Penglipuran, Trunyan, and Tenganan) presents a unique array of prospects and challenges for the local population, and for their relationships with nature. With a significant proportion of visitors being foreign and wealthy, at least by local standards, this once isolated region has been bombarded by the cultural and material influences and excesses of the developed world, especially in Songan, Jatiluwih, and Bayung Gede villages. In the Bali *Aga* villages, traditional cultural practices and values that characterized so many generations have been supplanted. The local population is now roughly divided between the younger generation, who cater to the tourist needs of outsiders, and the older generation, whose values and knowledge seem out of step with life in the region (Agung 2005).

While the process of intercultural behavioral acquisition can take many unpredictable turns (Fisher 2004), it seems inevitable that cultural erosion is accelerated by the process. TEK has little survival value in the increasingly commercialized and market-based economy of this and other regions (Voeks 2010).

Conclusions

Our analyses suggest a serious impact of modernization on Balinese TEK. Although our analyses were concentrated only on food and nutraceutical plants, we think that our results may be indicative of a more general loss of ethnonobotanical knowledge. This cultural erosion is practically unavoidable, but might be mitigated with appropriate cultural programs. Continued use and promotion of the Balinese life philosophy, the *Tri Hita Karana*, could lead local people to effectively conserve traditional knowledge and judiciously utilize the abundant natural resources of Bali, even after already having lost certain indigenous values and practices. Continued access to youth associations, *adat* law, and open communication between the older and younger generations will very likely encourage local people to conserve traditional knowledge about plant uses.

Table 5. Effects of geographic and socioeconomic variables on village ethnobotanical knowledge for younger people. Parameter values, standard errors, and associated probability levels of OLS best fit models for number of known plants (Np: R^2 =0.450, AICc =98.294); number known uses (Nu: R^2 =0.260, AICc =103.127); Shannon index of diversity (H: R^2 =0.473, AICc =17.366); Simpson index of dominance (D: R^2 =0.668, AICc = -54.59); Pielou index of equitability (J: R^2 =0.315, AICc = -102.628). GI1 = Globalization index 1; SE = Standard error; ß = Standardized coefficient; t = Student's t.

Np					Nu				
	Coefficient	ß	SE	t		Coefficient	ß	SE	t
Constant	63.367		13.333	4.753	Constant	25.209		4.495	5.608
Elevation	-0.02	-0.652	0.008	-2.466	Distance to the nearest village	5.043	510	2.563	1.968
GI1	-69.43	-0.640	28.693	-2.420					
H					D				
	Coefficient	ß	SE	t		Coefficient	ß	SE	t
Constant	4.87		0.593	8.211	Constant	-0.152		0.051	-2.972
Elevation	<0.001	-0.672	<0.001	-2.594	Elevation	<0.001	0.733	<0.001	3.362
GI1	-3.22	-0.653	1.276	-2.523	Distance to the main town	<0.001	0.486	<0.001	2.275
					GI1	0.281	0.892	0.075	3.722
J									
	Coefficient	ß	SE	t					
Constant	0.988		0.003	355.412					
Elevation	<0.001	-0.561	<0.001	-2.25					

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