Medicinal plants from swidden fallows and sacred forest of the Karen and the Lawa in Thailand

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Abstract

Background: Many ecosystem services provided by forests are important for the livelihoods of indigenous people. Sacred forests are used for traditional practices by the ethnic minorities in northern Thailand and they protect these forests that are important for their culture and daily life. Swidden fallow fields are a dominant feature of the agricultural farming landscapes in the region. In this study we evaluate and compare the importance of swidden fallow fields and sacred forests as providers of medicinal plants among the Karen and Lawa ethnic minorities in northern Thailand.

Methods: We made plant inventories in swidden fallow fields of three different ages (1–2, 3–4, 5–6 years old) and in sacred forests around two villages using a replicated stratified design of vegetation plots. Subsequently we interviewed the villagers, using semi-structured questionnaires, to assess the medicinal use of the species encountered in the vegetation survey.

Results: We registered a total of 365 species in 244 genera and 82 families. Of these 72(19%) species in 60(24%) genera and 32(39%) families had medicinal uses. Although the sacred forest overall housed more species than the swidden fallow fields, about equal numbers of medicinal plants were derived from the forest and the fallows. This in turn means that a higher proportion (48% and 34%) of the species in the relatively species poor fallows were used for medicinal purposes than the proportion of medicinal plants from the sacred forest which accounted for 17–22%. Of the 32 medicinal plant families Euphorbiaceae and Lauraceae had most used species in the Karen and Lawa villages respectively.

Conclusion: Sacred forest are important for providing medicinal plant species to the Karen and Lawa communities in northern Thailand, but the swidden fallows around the villages are equally important in terms of absolute numbers of medicinal plant species, and more important if counted as proportion of the total number of species in a habitat. This points to the importance of secondary vegetation as provider of medicinal plants around rural villages as seen elsewhere in the tropics.

Keywords: Ethnomedicinal plants, Protected forests, Traditional knowledge, Tribal community
5–15 years to regenerate to forest before they are again turned into crop cultivation [5]. The impact of this ecological transformation on the availability of usable plants is not well understood, and there is little research concerning the habitats from which shifting cultivators gather wild plants. Nevertheless the shifting cultivators still obtain many of the plants that they need for their livelihood from these fallow fields and regenerating forests [6].

Sacred forests are segments of the landscape that represent old traditions of preserving climax forest patches based on local culture and religious beliefs and they are found throughout the world. A sacred forest serves a functional link between cultural life and the forest management system of a region. Sacred forests have been studied in many parts of the world including Africa, [7], China [8], and especially in India [9-13]. Ethnobotanical studies of sacred forest in India [14-16] have documented informal management systems of sacred forest that not only conserve useful species, but also harbor many unique plants for which local people have discovered medicinal values [17,18]. Sacred forests are often seen as reservoirs of local biodiversity that provide a unique fauna and flora including their medicinal plants [11]. Depending on location and management, sacred forest provide a number of other ecosystem services such as cultural amenities but many of these aspects remain poorly explored [19]. Ecosystem services in the form of medicinal plants from sacred forest can be important for indigenous people in remote areas, since many rural communities depend on wild plants for their diet and livelihood [20]. In Thailand there are many different types and sizes of sacred forests, ranging from a single tree to large forests that sometimes cover entire mountains [21]. In northern Thailand sacred forests are geographically dispersed and often associated with ethnic minorities living in the mountains [22]. Local laws and customs usually limit the villagers’ activities in these forests. Hunting, grazing, and logging may be prohibited or restricted and villagers are conscientious not to damage them [23]. The ethnobotany of sacred forests has never been studied in Thailand.

Simplistic views of ethnoecological relationships between ethnic groups and their surrounding ecosystems often view the untouched virgin species rich forests as the main provider of useful plants, whereas secondary vegetation is often seen as degraded and useless. A growing body of evidence however points to these secondary recovering ecosystems as important providers of useful plants. Examples of how secondary vegetation make important contributions to the provision of useful plants come from the Amazon and the Atlantic forests in South America [24-26] and from Vietnam [27]. Here we study this phenomenon, which appears to be general, and we test whether it also occurs in a fallow/sacred-forest cultural landscape mosaic in northern Thailand.

The objectives of our study were to examine the ecosystem services from swidden fallow fields of different ages and adjacent sacred forests and in particular to compare how these different habitats provide medicinal plants in two ethnic minority communities in northern Thailand, one of the Karen and one of the Lawa. Specifically we asked the following questions: 1) How species rich are the fallow fields of different ages and the sacred forests and how many of their species have medicinal uses? 2) Of the species encountered how many are derived from each habitat and how many medicinal plants are provided by each habitat?

**Materials and methods**

**Study areas**

The study area is in Mae Cheam watershed in northern Thailand approximately 75 km southwest of the city of Chiang Mai. This watershed is important for its biodiversity and its varied forest types and vegetation and in addition it is inhabited by several ethnic minority groups [28]. Our study was focused on two villages of different ethnic groups, the Karen village Mae Hae Tai and the Lawa village Mude Lhong (Table 1). The Karen is the largest of ethnic group in Thailand [29]. There are four groups of Karens; the Sgaw Karen, the Bighwe Karen, the Pa-O Karen or Thaung thu and the Pwo Karen [30]. Karen-Sgaw is the largest group in Thailand and also in the Mae Cheam watershed-[29]. The Karen are autonomous and economically self-sufficient and live in remote and isolated areas and have rituals that focus on living in harmony with the nature that surrounds them [31,32]. The Lawa do not live outside of Thailand and are sometimes not counted among the hill tribes. The history of the Lawa is long and poorly understood [31]. Regardless of such disagreements about their assignment, the Lawa are a minority group in the northern Thailand [29]. Their economy is based on agriculture, with rice grown according to a sophisticated rotation shifting cultivation system [33]. The two villages are surrounded by several different habitats such as sacred forests, rice fields and swidden fallow fields of different ages. Villagers are only allowed, by the village committee, to extract minor forest products from the sacred forests in quantities that must be agreed upon [33]. In Mae Hae Tai (Karen), which is mainly Christian, villagers maintain traditional beliefs related to the forest that surrounds them and they worship the forest in tree ordination ceremonies to raise awareness of environmental protection and to build a spiritual commitment to conserve the forests and the watersheds [23]. In Mude Lhong (Lawa) which is Animistic-Buddhist [34] the inhabitants practice extensive traditional customs through
animists beliefs related to protecting their environment, rivers and forests. The sacred forest in Mae Cheam occur in a matrix of cultivated fields and fallows, which, in this watershed, are up to six years old although falls may be up to 15 years old elsewhere.

Data sampling
We established sampling plots around both villages in 2009 and 2010 in the sacred forest and swidden fallow fields of various ages (young fallow, 1–2 years; medium fallow, 3–4 years; old fallow, 5–6 years). Three plots (20 × 40 m) were laid out parallel to contour lines and these three plots were replicated in each habitat. In the 24 plots (total 1.92 ha) all plant species were collected and later identified at the Queen Sirikit Botanic Garden Herbarium (QSBG) with the help of taxonomic specialists J. F. Maxwell and M. Norsaengsri. Voucher specimens are deposited at the herbaria of the Department of Biology, Chiang Mai University and at Queen Sirikit Botanic Garden Herbarium (QSBG), Chiang Mai, Thailand. Based on species lists derived from the vegetation surveys of each habitat type, ethnobotanical data were gathered between August, 2011 and February, 2012 using semi-structured interviews. Our informants were villagers who were born and had always lived in the communities and their ages ranged from 15–84 years. Photographs of plants and freshly collected material from the swidden fallow fields and sacred forest were shown to the informants following established interview techniques [35,36]. The interviews were done in Karen and Lawa with the help of an interpreter. We made 35 interviews in the Karen village and 32 in the Lawa village corresponding to 10% and 11% their populations (Table 1). Prior to the start of interviews concerning the medicinal use of plants in the Karen village Mae Hat Tai and the Lawa village Mude Lhong communal meetings were held with all inhabitants, including the village leaders, during which the purpose and the methods of the study was explained and approved. It was agreed that the obtained results would be shared with the villagers in the form of a popular publication once the research had been formally published. In addition it was agreed that all informants would be asked for their prior informed consent individually before any interview was undertaken. Consequently such consent was obtained for each interview performed.

Data analyses
Jaccard’s Index (JI) was used to determine the similarity of medicinal plants species [37], which is based on the presence or absence of species on each list. Relating the number of species in common to the total number, it is expressed as:

\[
JI = \frac{c}{a + b + c} \times 100
\]

Where \(a\) is the number of species unique to area A and \(b\) is the number of species unique to area B, and \(c\) is the number of species found in both areas.

Use Value was calculated to determine the most important medicinal plant species in each habitat [38],

\[
U\text{V} = \frac{U_i}{N}
\]

Where \(U_i\) is the number of use-reports cited by each informant for a given species in each habitat and \(N\) is the total number of informants.

Linear regression was done to account for correlated responses between the age of fallow fields and total number of medicinal plants in each sampling sites. Chi-square test was used to analyze differences between habitat and

| Village              | Mae Hae Tai          | Mude Lhong          |
|----------------------|----------------------|----------------------|
| Ethnicity            | Karen                | Lawa                |
| Religion             | Christian            | Animists-Buddhism   |
| Co-ordinates         | 18°25′37.0″N, 98°12.7″E | 18°28′0.5″N, 98°11′25.5″E |
| Elevation (m) a.s.l. | 1,090                | 950                 |
| Households           | 67                   | 55                  |
| Population (males/females) | 346 (172/173) | 286 (136/150)      |
| Distance to nearest town (km) | 53                | 48                  |
| Total size of sacred forest (acres/ha) | 804/325            | 815/330             |
| Total size of swidden fallow fields (acres/ha) | 1,043/422          | 1,457/590           |
| Permanent cash crops | Cabbage (Brassica oleracea L.), Coffee (Coffea arabica L.) | Cabbage (Brassica oleracea L.), Onion (Allium ascalonicum L.), Flint corn (Zey mays L.) |
number of medicinal plants species in the two villages and to analyze if the sources of medicinal plants depend on the habitat. All analyses were done with the SPSS 16.0 software package for Windows.

**Results and discussion**

Species richness, number of medicinal plants and their taxonomic diversity

In total we registered 365 species, 245 in the Karen village and 240 in the Lawa village. The highest species richness was found in the sacred forests of both villages and the lowest number of species was found in the youngest (1–2 years old) fallow fields (Figure 1). We encountered 72 different species of medicinal plants belonging to 32 families and 60 genera (Table 2). Of these, 50 species in 44 genera and 27 families were used by the Karen and 32 species in 30 genera and 21 families were used by the Lawa. The most used plant families were Euphorbiaceae (6 species) in the Karen village and Lauraceae (5 species) in the Lawa village (Figure 2). Eleven families were used only by the Karen and not by the Lawa whereas five families were used only by the Lawa and not by the Karen (Figure 2).

Only 15% of the medicinal plants (11 species) were shared among the two villages (Figure 2). Most of the plant families that were used exclusively in one of the villages were represented by a single species, but it is noteworthy that Urticaceae had four medicinal species in the Lawa village and none in the Karen village.

*Costus speciosus* var. *speciosus* was the most important medicinal species in the 1–2 years old fallow fields and it had the highest UV in both villages (Table 3). In the Karen village, *Melastoma malabathricum* L. ssp. *norman* and *Eugenia cumini* var. *cumini* were the most important species in 3–4 and 5–6 years old fallow fields, respectively. In the Lawa village, *Phoebe lanceolata* was the most important medicinal plants in 3–4 years old fallow fields and also had highest UV in 5–6 years old fallow fields. In the sacred forest of the Karen *Ficus auriculata* had the highest UV and *Cinnamomum iners* had the highest UV in the sacred forest of the Lawa.

When compared to sacred forests and swidden fallow fields documented elsewhere in South East Asia and in Africa (Table 4), the species richness and the number of medicinal plants reported here are within the range reported in those other studies.

Euphorbiaceae, which was the most important medicinal plant family in the Karen village, is common among medicinal plant families from sacred forests and swidden fallow fields elsewhere. The Lauraceae, which was the dominant medicinal plant family in the Lawa village, is important in only one of the other studies cited, i.e., from Megalhay in India (Table 4). The two villages studied here are quite different in terms of the taxonomic origin of the medicinal plants (Figure 2) demonstrating that these two cultures, even if living in a shared habitat, have developed taxonomically different medicinal plant systems.

Sources of the medicinal plants

The overall species richness increased from young over old fallow fields to sacred forest, and about equal numbers of medicinal plant species were derived from the four different habitat types around the villages (Figure 1). Overall the number of medicinal plant species from each habitat varied from 16–30. The differences were not significant, neither overall ($\chi^2 = 1.62, df = 3, p = 0.65$) nor when the villages were tested separately (Karen: $\chi^2 = 0.50, df = 3, p = 0.91$; Lawa: $\chi^2 = 1.30, df = 3, p = 0.72$). Linear regression test in both villages showed that the age of the fallow fields was a weak factor and had negatively significant effect on the total number of medicinal plants ($R^2 = 0.014, Coefficients = -1.181, F = 6.224, p = 0.01$) and also negative effect in each village but without significant differences (Karen;
Table 2 List of medicinal plants used by the villagers in a Karen and a Lawa village in the Mae Cheam watershed in northern Thailand

| Species – Family (Voucher no.) | Local name | Source habitat of Medicinal plants |
|--------------------------------|------------|-----------------------------------|
|                                |            | Swidden cultivation fields        | Sacred forest |
|                                |            | 1-2 Years | 3-4 Years | 5-6 Years | Karen | Lawa | Karen | Lawa | Karen | Lawa | Karen | Lawa | Karen | Lawa |
| Acacia concinna (Willd.) DC.- LEGU (AJK004, AJL001) | Po chi sa | Som poi | - | - | - | - | √ | - | - | - | - | √ |
| Acrocarpus fraxinifolius Wight ex Am. – LEGU (AJK 048) | Law bor dey | - | - | √ | - | √ | - | - | - | - | - | - |
| Actinodaphne henryi Gamb. – LAUR (AJL 164) | Sey leu sa, Sey nesy sa, Tur see sor | - | - | - | - | - | - | - | - | - | - | - |
| Aglaia elliptica Blume – MELI (AJK 141, AJL 136) | - | - | - | - | - | - | - | - | - | - | - | - |
| Aglaia lawii (Wight) Sald. ex Rama. | Sey pi | - | - | - | - | - | - | - | - | - | - | - |
| Alstonia scholaris (L.) R. Br. – APOC (AJK 003, AJL 063) | Nor bey, Pa bor eu Hyar, Sa weing | - | - | - | - | - | - | - | - | - | - | - |
| Aphananthe aspera (Thunb.) Planch. – ULMA (AJK 230) | Pore loo too, Sa deui cwa | - | - | - | - | - | - | - | - | - | - | - |
| Artocarpus nitidus Trec. | Pore loo too, Sa deui cwa | - | - | - | - | - | - | - | - | - | - | - |
| Bauhinia glauca (Wall. ex Bth.) Bth. ssp. tenuiflora (Watt ex Cl.) K. & S.S. Lar. – LEGU (AJK 245) | Per na meu too | - | - | - | - | - | - | - | - | - | - | - |
| Bochmeria nivea (L.) Gaud. var. tenacissima (Roxb.) Miq. -URTI (AJL 090) | Hyew | - | - | - | - | - | - | - | - | - | - | - |
| Boerhavia malabarica Wall. ex Wedd. – URTI (AJL 040) | Kang poi | - | - | - | - | - | - | - | - | - | - | - |
| Bremia retusa (Dennst.) Alst.- EUPH (AJK 179) | Mi ni mey | - | - | - | - | - | - | - | - | - | - | - |
| Brucea mollis Wall.- SIMA (AJK 045) | Sey gor wey | - | - | - | - | - | - | - | - | - | - | - |
| Buddleja asiatica Tour.- BUDD (AJK 034) | Pore gi braa | - | - | - | - | - | - | - | - | - | - | - |
| Callicarpa arborea Roxb. var. arborea – VERB (AJK 023) | Poh qui | - | - | - | - | - | - | - | - | - | - | - |
| Calophyllum polyanthum Wall. ex Choisy- CLUS (AJK 022) | Seu mee la | - | - | - | - | - | - | - | - | - | - | - |
| Catunaregam spathulifolia Tirveng. – RUBI (AJK 204) | Puci sa mu | - | - | - | - | - | - | - | - | - | - | - |
| Celtis tetrandra Roxb.- ULMA (AJL 072) | Coh tia gleing | - | - | - | - | - | - | - | - | - | - | - |
| Chionanthus ramiflorus Roxb.- OLEA (AJK 148) | Bey plor sa | - | - | - | - | - | - | - | - | - | - | - |
| Chisocheton cumingianus (C. DC.) Harms ssp. balansae (C.DC.) Mabb.- MELI (AJK 100) | Sa me jeu | - | - | - | - | - | - | - | - | - | - | - |
| Chromolaena odorata (L.) R. M. King & H. Rob.- ASTE (AJK 066, AJL 220) | Chor per gwe | - | - | - | - | - | - | - | - | - | - | - |
| Cinnamomum iners Reinw. ex Bl. –LAUR (AJL 044) | Bai heng, My hoam | - | - | - | - | - | - | - | - | - | - | - |
| Cleometum serratum (L.) Moon var. serratum- VERB (AJL 120) | Coh song sarn | - | - | - | - | - | - | - | - | - | - | - |
| Colebrookia oppositifolia Smith- VERB (AJL 155) | Coh tia gleing | - | - | - | - | - | - | - | - | - | - | - |
| Costus speciosus (Koeh.) J.E. Sm. var. speciosus – COST (AJK 002, AJL 088) | Su ley bo | - | - | - | - | - | - | - | - | - | - | - |
| Cratoxylum formosum (Jack) Dyer ssp. pruniflorum (Kurz) Gog.- CLUS (AJL 097) | Gu gi, Toh toi | - | - | - | - | - | - | - | - | - | - | - |
| Dalbergia cangoldiana Graham. ex Bth.- LEGU (AJL 217) | Hyu | - | - | - | - | - | - | - | - | - | - | - |
| Dendrocnide stimulans (L.f.) Chew- URTI (AJL 147) | Tug kleing, Dian | - | - | - | - | - | - | - | - | - | - | - |
| Plant Name | Local Names | Other Names | Habitat |
|------------|-------------|-------------|---------|
| Desmos dumosus (Roxb.) Saff. var. glabrior Craib - ANNO (AJK 120) | Pore na seu | - | - |
| Eugenia cumini (L.) Druce var. cumini – MYRT (AJK 032) | Sey mee su, Sey grey gwa | - | √ |
| Eugenia fruticosa (Roxb. ex DC.) Roxb. – MYRT (AJK 074) | Sir me | - | √ |
| Eurya accuminata DC. – THEA (AJL 029) | Coh joung, Coh hmoi | - | √ |
| Ficus auriculata Lour. – MORA (AJK 007) | Ta geu ha | - | - |
| Ficus carpillipes Gagnep. – MORA (AJL 087) | Ye ya gor | - | - |
| Ficus virens Aiton var. virens– MORA (AJK 082) | Clur sa | - | - |
| Flacourtia indica (Blume) Merr. – FLAC (AJL 234) | Mi gai | - | √ |
| Glochidion eriocarpum Champ. – EUPH (AJK 065) | Sey pore meu pra | - | √ |
| Glochidion sphaerogynum (M.A.) Kurz – EUPH (AJK 067) | Tur si phlaa | - | √ |
| Gmelina arborea Roxb. – VERB (AJK 252, AJL 083) | Sey gor wey Ga hor | - | √ |
| Helicteaes hirsuta Lour. – STER (AJK 181) | Poa ji gwey | - | √ |
| Helicteres elongata Wall. ex Boj. – STER (AJK 121) | Ta gor eh | - | √ |
| Ilex umbellulata (Wall.) Loes. – AQUI (AJK 199) | Bley bor sa | - | - |
| Indigofera tinctoria Linn. – LEGU (AJK 244) | Sor me moo boa coa | - | - |
| Kopsia aborea Blume – APOC (AJK 182) | Ti chi cho por | - | - |
| Leea indica (Burm. F.) Merr. – LEEA (AJK 131, AJL 080) | Sey bor sa Dird | - | √ |
| Litsea cubeba (Lour.) Pers. var. cubeba – LAUR (AJL 008) | Coh loh | - | - |
| Litsea elongata (Wall. ex Nees) Bth. & Hk.f. – LAUR (AJK 127) | Nor tu leu | - | - |
| Litsea monopetala (Roxb.) Pers. – LAUR (AJK 154, AJL 165) | Pey jeu ya Hyum ngo, Hyeung | - | √ |
| Mallotus sp. – EUPH (AJL 235) | Co wan | - | - |
| Mangifera coloneura Kurz – ANAC (AJL 233) | Coh pae | - | - |
| Maoutia puva (Wall. ex Hook) Wedd.- URTI (AJL 177) | Hyei | - | - |
| Melastoma malabathricum L. ssp. norman D. Don K. Meyer- MELA (AJK 019) | Sey la pley | - | - |
| Melicope pteleifolia (Champ. ex Bth.) T. Hari- RUTA (AJK 250) | Pa sa ley | - | - |
| Millettia pachycarpa Bth.- LEGU (AJK 084) | Cher dui meu | - | - |
| Musaeum parva Wall. ex. G. Don - RUBI (AJK 191) | Go wa sa | - | - |
| Pavetta indica L. – RUBI (AJL 113) | Coh ca tok | - | - |
| Phoebe lanceolata (Nees) Nees – LAUR (AJK 047, AJL 122) | Sey glow bow Coh sa loh, Hyom hngo | - | √ |
| Phyllanthus emblica L.–EUPH (AJK 090) | Sey ya sa | - | - |
| Picrasma javanica Bl.- SIMA (AJL 182) | Sa geun | - | - |
| Sambucus javanica Reinw. ex Blume-CAPR (AJK 088, AJL 026) | Ta si ga jeu La oil toui | - | - |
| Sapindus rarak DC. – SAPI (AJL 025) | Glerw | - | - |
R² = 0.044, Coefficients = -0.513, F = 3.606, p = 0.06: Lawa; 
R² = 0.044, Coefficients = -0.523, F = 3.606, p = 0.06). This explains that the age of fallow did not affect the total number of medicinal plants. So although the sacred forest is much older and richer in species than the fallow fields, they do not provide higher number of medicinal plant species (Figure 1).

Because the four habitat types provide roughly similar numbers of medicinal plants even if their overall species richness is significantly different, the proportion of the species that is used medicinally of a given habitat is greatly different. The young (1–2 years) fallow fields have few species but 48% and 34% of them are used medicinally by the Karen and the Lawa, respectively. In the species rich sacred forests, in contrast, only 22% and 17% of the species are used medicinally (Figure 1).

The overall proportion of medicinal plants and non-medicinal plants in each habitat in the two villages were significantly different ($\chi^2 = 19.30, df = 3, p = 0.00$) also when the village were tested separately (Karen: $\chi^2 = 10.57, df = 3, p = 0.01$; Lawa: $\chi^2 = 21.00, df = 3, p = 0.00$).

The swidden fallow fields of different ages of regeneration and the sacred forests provided about equal numbers

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**Table 2 List of medicinal plants used by the villagers in a Karen and a Lawa village in the Mae Cheam watershed in northern Thailand (Continued)**

| Species                                  | Karen | Lawa |
|------------------------------------------|-------|------|
| Sauropus quadrangularis (Willd.) M.-A.- EUPH (AJK 144) |       |      |
| Shorea roxburghii G.Don.- DIPT (AJK 196) |       |      |
| Tarennoidea wallichi (Hk.f.) Tirv. &Sastre - RUBI (AJK 113, AJL 093) |       |      |
| Terminalia chebula Retz. var. chebula - COMB (AJK 057) |       |      |
| Todalia asiatica (L) Lmk. – RUTA (AJK 005) |       |      |
| Trema orientalis (L) Bl.- ULMA (AJK 076) |       |      |
| Triadica cochinchinensis Lour- EUPH (AJK 111) |       |      |
| Vitex sp.- VERB (AJK 109) |       |      |
| Wendlandia scabra Kurz. var. scabra – RUBI (AJL 051) |       |      |
| Ziziphus oenoplia var.brunoniana Tardieu Mill- RHAM (AJK 015) |       |      |

The family name of each plant species is indicated by the first four letters in upper case of the Latin family name. Vouchers were collected in the numberseries of Auemporn Junsongduang (AJK for Karen, and AJL for Lawa) and deposited in the herbaria of the Ethnobotanical Research Unit, Department of Biology, Faculty of Science, Chiang Mai University and Queen Sirikit Botanic Garden Herbarium, Chiang Mai Thailand: √ = present; - = Absent.

Figure 2 Number of medicinal species per plant family in a Karen and a Lawa village in the Mae Cheam watershed in northern Thailand.
of medicinal plant species to the two villages. This is surprising when seen in the light of the much higher overall species richness of the sacred forest compared to the surrounding swidden fallow fields. The more intense use of the secondary vegetation of the fallows may be because they are closer to where the villagers have their houses. Another possible explanation may be discouragement coming from the village council’s desire to conserve the sacred forest. The fallow fields, in contrast, are part of the productive land surrounding the villages and the swidden fallows belong to individual villagers which eliminates any problem related to ownership, etc. It is interesting that the most recently abandoned field, i.e., the swidden fallows that are 1–2 years old, have the highest proportion of their species being used medicinally. This preference for using secondary vegetation as a source of medicinal plants has previously been demonstrated in the Atlantic Forest of Brazil [24] and also among the ribeirinhos of Amazonian Brazil [26], in dry forest of northeastern Brazil [25] and in Vietnam [27]. It appears that different forests are used and valued differentially, not only with regard to usefulness but also in symbolic-religious terms and together they protect traditional botanical knowledge, people’s health and forests. Nonetheless, sacred forests remain important as providers of medicinal resources in the tribal communities not only in Thailand but also elsewhere in the region.

### Conclusion

Sacred forest and their surrounding fallow fields of different age of regeneration provided approximately the same number of medicinal plant species to both villages. Because the fallow fields were less species rich, the

| Village | 1-2 Years | 3-4 Years | 5-6 Years | Sacred forests |
|---------|-----------|-----------|-----------|----------------|
| Karen   | Costus speciosus (Koeh.) J.E. Sm. var. speciosus | Melastoma malabathricum L. ssp. norman D. Don K. Meyer | Eugenia cuminii (L.) Druce var. cuminii | Ficus auriculata Lour. |
| Lawa    | Costus speciosus (Koeh.) J.E. Sm. var. speciosus | Phoebe lanceolata (Nees) Nees | Phoebe lanceolata (Nees) Nees | Cinnamomum iners Reinw. ex Bl. |

| Table 3 The most used species of medicinal plants and their UV (Use-Value) in four different habitats around a Karen and a Lawa village in northern Thailand |

| Species | UV | Species | UV | Species | UV |
|---------|----|---------|----|---------|----|
| Karen   |    | Lawa    |    |
| Costus speciosus (Koeh.) J.E. Sm. var. speciosus | 0.42 | Costus speciosus (Koeh.) J.E. Sm. var. speciosus | 0.31 |
| Melastoma malabathricum L. ssp. norman D. Don K. Meyer | 0.34 | Eugenia cuminii (L.) Druce var. cuminii | 0.34 |
| Ficus auriculata Lour. | 0.08 |

### Table 4 Species richness and number of medicinal plant species in sacred forests and swidden fallow fields in 11 selected localities in South East Asia and Africa compared to the numbers reported in this study

| Locality | Species richness | Medicinal plants (%) | Most important families |
|----------|------------------|-----------------------|------------------------|
| Sacred forest |              |                       |                        |
| India, Kodagu district, Karnataka state¹ | 241 | 136 | 56% | - |
| India, Meghalaya state² | - | 80 | - | Lauraceae, Euphorbiaceae |
| India, Manipur state³ | - | 120 | - | Asteraceae, Verbenaceae |
| India, Kanyakumari district, Tamil Nadu state⁴ | 329 | 34 | 10% | Rutaceae, Euphorbiaceae |
| India, Cuddalore district, Taminadu⁵ | - | 33 | - | Leguminosae, Agavaceae |
| India, Sikkim state⁶ | 241 | 41 | 17% | - |
| India, Virudhunagar district, Tamil Nadu state⁷ | - | 53 | - | Leguminosae, Moraceae |
| India, Andhra Pradesh state⁸ | - | 18 | - | Loganiaceae, Leguminosae |
| Thailand, Mae Cheam district, Chiang Mai province⁹ | 221 | 50 | 22% | Euphorbiaceae, Lauraceae |

| Swidden fallow fields |              |                       |                        |
| Thailand, Mae La Noi district, and Muang district, Mae Hong Son province¹⁰ | 489 | 84 | 17% | Euphorbiaceae, Leguminosae |
| Lao, Pha Oudom district, Bo Kaeo province¹¹ | 141 | 58 | 41% | Leguminosae, Euphorbiaceae |
| Nigeria, Lagos state¹² | 104 | 48 | 46% | Euphorbiaceae, Leguminosae |
| Thailand, Mae Tang district Chiang Mai province¹³ | 295 | 119 | 40% | - |
| Thailand, Mae Cheam district, Chiang Mai province¹⁴ | 218 | 75 | 34% | Euphorbiaceae, Lauraceae |

¹[14], ²[15], ³[16], ⁴[17], ⁵[18], ⁶[19], ⁷[20], ⁸[21], ⁹[22], ¹⁰[23], ¹¹[24], ¹²[25], ¹³[26], ¹⁴[27].
proportion of their species with medicinal uses was consequently higher. Sacred forests are conserved as community forest and they make up a network of protected forest in northern Thailand [22]. Nevertheless it seems, as we document here, that fallow fields after swidden cultivation are equally important as providers of medicinal plants to the ethnic minorities in northern Thailand.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
The article was initiated by AJ, who recorded and analyzed data and prepared the first write-up of the manuscript. HB has critically edited and shaped subsequent versions. AI, AJ, PW have read and approved the final version of the manuscript. All authors read and approved the final manuscript.

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References
1. Millennium Ecosystem Assessment: Ecosystems and human well-being: A framework for assessment. Washington DC: Island Press; 2003.
2. Schmidt-Vogt D: Defining degradation: The impacts of swidden on forests in northern Thailand. Mit Res Dev 1998, 18(2):135–149.
3. Rerkasem K: Shifting cultivation in the mountainous mainland southeast Asia: The search for appropriate and sustainable land use, and its contribution to the improvement of rural livelihoods. In a workshop on Recent Environmental Change in Southeast Asia Japan: Nagoya University, 2000.
4. Schmidt-Vogt D: Swidden farming and fallow vegetation in northern Thailand. Stuttgart: Franz Steiner Verlag; 1999.
5. Sutthi C: Highland agriculture: From better to worse. In Hill Tribes Today. Edited by McNicol J, Verme B, White-Lotus: Bangkok and Paris; 1985:107–142.
6. Delang C: Ecological succession of usable plants in an eleven-year fallow cycle in northern Lao P.D.R. Ethnobot Res Appl, 2007; 5:331–350.
7. Mgumia FH, Oba G: Potential role of sacred groves in biodiversity conservation in Tanzania. Environ Conserv 2003, 30(3):259–265.
8. Sallick J, Amend A, Anderson D, Hoffmeister K, Gunn B, Zhendong F: Tibetan sacred sites conserve old growth trees and cover in the eastern Himalayas. Biodivers Conserv 2007, 16:959–706.
9. Upadhyaya K, Barik SK, Pandey HH, Tripathi OP: Response of woody species to anthropogenic disturbances in sacred forests of northeast India. Int J Ecol Environ Sci 2008, 34(3):245–257.
10. Khan ML, Khumbongmayum AD, Tripathi RS: The sacred groves and their significance in conserving biodiversity an overview. International Journal of Ecology and Environmental Science 2008; 34(3):277–291.
11. Ormsby AA, Bhagwat SA: Sacred forests of India: a strong tradition of community-based natural resource management. Environ Conserv 2010, 37:320–326.
12. Negi CS: Traditional culture and biodiversity conservation: Examples from Uttarakhand, central Himalaya. Mit Res Dev 2010, 30(3):259–265.
13. Jayan V, Uniyal SK, Jayan V, Uniyal SK, Gopichand, Singh RO, Lal B, Kumar A, Sharma V: Role of traditional conservation practice: Highlighting the importance of Shivbari sacred grove in biodiversity conservation. Environmentalist 2010, 30:101–110.
14. Borah AT, Vasudeva R, Bhagwat SA, Kushalappa CG: Do informally managed sacred groves have higher richness and regeneration of medicinal plant than state-managed reserve forest? Curr Sci 2003, 84:804–808.
15. Laloo RC, Kharlukhi L, Jeva S, Mishra SP: Status of medicinal plants in the disturbed and the undisturbed sacred forests of Meghalaya, northeast India: Population structure and regeneration efficacy of some important species. Curr Sci 2005, 90(2):224–232.
16. Khumlongmayum AD, Khan ML, Tripathi RS: Ethnobotanical medicinal plants in the sacred groves of Manipur. Indian Journal of Traditional knowledge 2005, 4:121–32.
17. Sukumaran S, Raj ADS: Medicinal plants of sacred groves in Kanyakumari district southern Western Ghats. Indian Journal of Traditional Knowledge 2010, 9(2):294–299.
18. Anbarashan M, Padmavathy A: Ethno-medicinal plants in five sacred groves in Cuddalore district, Tamilnadu, India. Ethnobotanical Leaves 2010, 14:74–78.
19. Ray R, Subash Chandran MD, Ramachandra TV: Ecosystem services from sacred groves of Uttar Kannada: A case study. Bangalore: Conference 22nd–24th December 2010; Indian Institute of Science, 2010.
20. Gadgil M, Vartak VD: Sacred groves of India: A plea for continued conservation. Journal Bombay Natural History Society 1975, 73:314–320.
21. Sponser LE, Nateshda-Sponser P, Ruttandakul N, Junadiadich S: Sacred and/or secular approaches to biodiversity and conservation in Thailand. Worldviews 1998, 2:155–167.
22. Ganjanapan A: Local control of land and forest: cultural dimension of resources management in northern Thailand. Chiang Mai, Thailand: Regional Center for Social Science and Sustainable Development (RCSD), 2000.
23. Fufuang T: The history of hill tribes; Understanding with different culture, Chiang Mai, Thailand: Hill Tribes Research Institute, 2000.
24. Voeks RA: Tropical forest healers and habitat preference. Econ Bot 1996, 50:381–400.
25. Albuquerque UP, Andrade LHC, Oliveira de Silva AC: Use of plants resources in a seasonal dry forest (northeastern Brazil). Acta Botanica Brasilica 2005, 19(1):27–38.
26. Couly C, Sir P: Use and knowledge of forest plants among the Ribeninhos, a traditional Amazonian population. Agrofor Syr 2012, 87(3):543–554. doi: 10.1007/s10457-012-9758-5; no page number.
27. Tran VO, Do Q, Le DB, Jones B, Wunder J, Russell-Smith J: A survey of medicinal plants in BaVi National Park, Vietnam: Methodology and implication for conservation and sustainable use. Biol Conserv 2001, 97(3):295–304.
28. Khamyong S, Seramethakun A, Naktippawan C: Importance of Shivbari sacred groove in biodiversity conservation. Modern Biodivers Conserv 1999, 30(3):295–304.
29. Tribe Research Institute: Tribal population summary in Thailand. Chiang Mai, Thailand: Tribal Research Institute; 1992.
30. Siriwat B: Hill tribes in Thailand. Pranakorn (Siam), Thailand: Odlan Store; 1963.
31. Mischung R: The hill tribes of northern Thailand: Current trends and problems of their integration into the modern Thai nation. In Regional and National Integration in Thailand, 1892–1992. Edited by Grabowsky V, Westbaden, Germany: Harrassowitz Verlag; 1995.
32. Yos S: Biodiversity and indigenous knowledge for sustainable development. Biodiversity and Indigenous Knowledge Studies Center for Research and Anthropology Department, Faculty of Science, Chiang Mai University, Thailand, 2009.
33. Village Committee: Community Plan for Strategy Furtherance of Chiang Mai province. Chiang Mai, Thailand: Annual Report of Mude Lhong village; 2009.
34. Young G: The Hill Tribes in Northern Thailand. Bangkok, Thailand: Siem Society, 1962.
35. Martin GA: Ethnobotany: A Methods Manual. London: Chapman and Hall; 1995.
36. Thomas E, Vanderbroek I, Van Damme P: What works in the field? A comparison of different interviewing methods in ethnobotany with special reference to the use of photographs. *Econ Bot* 2007, 61(4):376–384.

37. Höft M, Bank SK, Lykke AM: Quantitative ethnobotany. Applications of multivariate and statistical analysis in ethnobotany. UNESCO, Paris: People plant working paper; 1999.

38. Phillips O, Gentry AH, Raynel C, Wilkin P, Durand BC: Quantitative ethnobotany and Amazonian conservation. *Journal of conservation biology* 1994, 8:225–248.

39. Dash SS: Kabi sacred groves of north Sikkim. *Curr Sci* 2005, 89(3):427–428.

40. Rajendran SM, Agarwal SC: Medicinal plants conservation through sacred forests by ethnic tribes of Virudhunagar district, Tamil Nadu. *Indian Journal of Traditional knowledge* 2007, 6(2):329–333.

41. Kumar RB: Flora of sacred groves at Srisailam island, Andhra Pradesh, India. *Ethnobotanical Leaflets* 2010, 14:20–426.

42. Kunstadter P, Chapman EC, Sabhasri S: Farmers in the forest. Economic development and marginal agriculture in northern Thailand. University Press of Hawaii, Honolulu; 1983.

43. Oni PI: Ethnobotanical survey of a fallow plot for medicinal plants diversity in Idena village Ijebu-Ode, south-western Nigeria. *Journal of Medicinal Plants Research* 2010, 4(7):509–516.

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