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Ethnobotanical Study of Plants used for construction, handicrafts and fiber in Southern Shan State, Myanmar

Dr. Thant Shin, Assistant Director, Forest Research Institute

Kazumi Fujikawa

Aung Zaw Moe, Hiroshi Uchiyama

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Dr. Thant Shin, Assistant Director, Forest Research Institute
Kazumi Fujikawa, Kochi Prefectural Makino Botanical Garden, Japan
Aung Zaw Moe, Research Officer, Forest Research Institute
Hiroshi Uchiyama, Nihon University, Japan

Abstracts

In Myanmar, rural communities still depend on forests for their livelihood. Assessment of the subsistence use of plant diversity is essential for the sustainable use of plant resources. Ethnobotanical data were collected in three villages each with different historical backgrounds in Southern Shan State. DNA barcoding was used to facilitate species identification. A total of 93 plant species from 38 families was recorded as sources for construction, handicrafts and fiber. High economic potential of *Toona sureni* was uncovered. The majority of species assessed (83%) are extracted from the wild. Traditional knowledge of local communities should be given priority for conservation ensuring for the sustainable utilization of plant resources.

Key words: Ethnobotany, DNA barcoding, Myanmar, Southern Shan State

ရှမ်းပြည်နယ်တောင်ပိုင်းတွင်ဆောက်လုပ်ရေးပစ္စည်း၊ လူသုံးပစ္စည်းများနှင့် လျှော်အဖြစ်အသုံးပြုလျက်ရှိသည့် အပင်များအား လူမှု ရုက္ခဗေဒ ရှုထောင့်မှ လေ့လာခြင်း

ဒေါက်တာသန့်ရှင်း
လက်ထောက်ညွှန်ကြားရေးမှူး
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

ဒေသခံပြည်သူများ၏ နေ့စဉ်လူမှုဘဝအတွက် သစ်နှင့် သစ်တောထွက်ပစ္စည်းများမှာ အရေးပါလျက်ရှိပါသည်။ အပင်သယံဇာတများအား စဉ်ဆက်မပြတ်အသုံးချနိုင်ရေးအတွက် ဒေသခံပြည်သူများ အသုံးပြုလျက်ရှိသည့် အပင်များအား စနစ်တကျ လေ့လာမှတ်တမ်းတင်ရန်လိုအပ်ပါသည်။ လူမှုရုက္ခဗေဒဆိုင်ရာ အချက်အလက်များအား ရှမ်းပြည်နယ် တောင်ပိုင်းရှိ ကျေးရွာ သုံးရွာ တွင် အခြေပြု၍ စုဆောင်းခဲ့ပါသည်။ အပင်မျိုးခွဲခြင်းအတွက် DNA Barcoding နည်းပညာကိုပါ အသုံးပြုခဲ့ပါသည်။ ဆောက်လုပ်ရေးပစ္စည်း၊ လူသုံးပစ္စည်းများနှင့် လျှော်အဖြစ်အသုံးပြုလျက်ရှိသည့် အပင်မျိုးစိတ် ၉၃ မျိုးအား လေ့လာမှတ်တမ်းတင်နိုင်ခဲ့ပါသည်။ ၎င်းတို့အနက် ၈၃ % မှာ သဘာဝတောများမှ ထုတ်လုပ်သုံးစွဲလျက်ရှိကြောင်း လေ့လာသိရှိရပါသည်။ သစ်တော သယံဇာတများစဉ်ဆက်မပြတ် အသုံးချနိုင်ရေးအတွက် ဒေသခံပြည်သူများ၏ ရိုးရာအသိ ပညာများအား ဦးစားပေး စဉ်းစားဆောင်ရွက်ရန် လိုအပ်ပါကြောင်း တင်ပြအပ်ပါသည်။

Ethnobotanical Study of Plants used for construction, handicrafts and fiber in Southern Shan State, Myanmar

1. Introduction

Ethnobotany is the discipline concerned with studying human interactions with plants and their habitats, often with an emphasis on their traditional use, with the management of plant resources viewed from an historical perspective (Pei et al. 2009). The use of forest products for subsistence is of great importance to people (Duchelle 2007). The wood is the most important forest product and it has contributed a lot in the development of various civilizations from time immemorial (Kharwal & Rawat 2009). The modernization of rural societies was characterized by a shift from subsistence farming/hunting and gathering to a market oriented economy and considerable improvement in healthcare resulted in a major change of life style in the local population (Abbet et al. 2014). However, the cultural association of plants and people is rarely studied, recorded or poorly understood and under appreciated (Jain 2000). Through the process of modernization the loss of traditional knowledge concerning the use of wild plant species has become a very serious issue (Grivetti & Ogle 2000).

Myanmar is one of the hotspots of biodiversity (Myers et al. 2000; Krupnick & Kress 2003) and is rapidly losing its forests due to increasing development and population growth. In Myanmar, rural communities still depend on forests for timber, fuel-wood, fodder, and bamboo (Hlaing et al. 2017). Therefore, an accurate understanding of plant diversity in Myanmar is urgently required and ethnobotanical studies assist in providing new and relevant information on natural plant resources (Hidayati et al. 2015; Rao & Natesh 2008). There are one hundred and thirty-five officially recognized ethnic groups in Myanmar (Ministry of Immigration and Population 2014), and each of these indigenous groups regard natural resources as essential to their culture and well-being (FAO 2010), and the conservation and sustainable use of these resources should be paramount. However, the reliance of rural people on ecosystems is rarely examined and thus typically overlooked in national politics and economics, resulting in inappropriate strategies that do not take into account the role of the environment (Ono & Suzuki 2013). In Myanmar, ethnobotany has been the focus of many studies in recent times but the emphasis has usually been on medicinal properties and the subsequent financial benefits and incentive for local communities (Ono & Suzuki 2013; Thantsin et al. 2016; Peters et al. 2007; Oo et al. 2011).

In the present study, DNA barcoding techniques were used to facilitate species identification. DNA barcoding can aid in the taxonomic identification of plants by using a short, standard DNA region that is universally present in the target lineages and has sufficient sequence variation to identify species and assign unidentified individuals to their correct species (Hebert et al. 2003; von Cräutlein et al. 2011). The chloroplast rbcL gene is useful for surveying a regional flora of which is poorly known (Tobe et al. 2010). DNA barcoding will significantly augment morphology-base identification in many sectors and endeavors, will emerge more and more as a species-discovery tool, and will become routine for the scientific community (Janzen et al. 2009).

Table 1. Basic information of three villages studied

	Myin Ka	Pin-sein-pin	Eden
Establishment	Before late 19the century (Moved from nearby old village, one mile away).	Early 19th century	1990
Location	N: 20°34´54.3", E: 96°34´52.7"	N: 20°58´54.3", E: 96°37´54.9"	N: 19°55´31.9", E: 96°25´58.1"
Above sea level	1422 m	1736 m	353 m
Habitat	Evergreen forest	Evergreen forest	Deciduous forest
Linear distance to the nearest town	6 miles to Kalaw, Shan State	5 miles to Pindaya, Shan State	25 miles to Tatkone, Mandalay Division
Population/ Households	563/ 140	535/127	410/68
Ethnic Group	Majority: Taung-yoe, Danu Minority: Bamar, Shan	Majority : Danu Minority: Bamar, Pao	Majority: Kayan Minority: Kayin, Bamar
Religion	Buddhism	Buddhism	Christian and Buddhism
Public facility	One library, one primary school, one buddhist monastery	One primary school, one library, one kindergarten	One middle school, one church, one monastery, one kindergarten
Subsistence	Rice cultivation ca. 60 acres. Cultivation of vegetables and fruits: Ginger, cabbage, cauliflower, egg plants, tomato, chili, chayote, carrot, orange, avocado, pear (ca. 150 acres)	Plantation of tea leaves, *Ju,* pea, cabbage, Potato	Cultivation of turmeric, chili, banana, hill rice. Collection of bamboo shoots and other forest products
Home garden products	Ginger, orange, avocado, pear,	Tea leaves	Mango, banana, jack fruit
Live stock	Buffalo, chicken, cattle, pig	Cattle, chicken	Pig, chicken
Drinking Water	Natural springs (connected with pipe line)	Collection of rain water with collection tanks	Natural springs (connected with pipe line)
Electricity	From national grid	No electric supply	Small hydropower generators constructed on the stream

Figure1. Location map of study area

2. Objectives

The specific aims of this study are to document the traditional knowledge and practices of plants in Southern Shan State, Myanmar, and compile a checklist of plants used by local communities for construction, handicrafts and fiber.

3. Materials and Methods

Place of study

The Shan plateau to the east rises abruptly from the central basin of Myanmar, often in a single step of 600 m. Occupying the eastern half of the country, the Shan plateau is deeply dissected with an average elevation of about 900 m (Hadden 2008). Northward, the plateau merges into the northern mountains, and southward it continues into the Dawna Range and to the Peninsular Tenasserim Mountains. The Shan plateau, because of its elevation, receives between 1900 mm and 2000 mm of precipitation annually with an average daily temperature of 22 ºC (Hadden 2008). The present study was based on an ethnobotanical analysis of plants used for construction, handicrafts and fiber in the western part of the Shan plateau. We conducted field researches in three villages each with different historical backgrounds, namely Eden (E), Myin Ka (M), and Pin-sein-pin (P) (Fig. 1 and Table 1). The ethnic groups residing in the study area are *Danu, Taung-yoe, Shan, Bamar, Pao, Kayan* and *Kayin.* The main ethic groups in Myin Ka and Pin-sein-pin Village are *Danu* and *Taung-yoe*. The main ethnic group in Eden Village is *Kayan*. According to the folklore of the villagers, old Myin Ka Village was established in the *Bagan* Era (9th -13th century) one mile away from the current village locatin. In late 19th century, the old village was destroyed because of ethnic conflicts in the area and was moved to its current location. Pin-sein-pin Village was established in the early 19th century. Eden Village was established in 1990. The villagers of Eden Village migrated from Kaya State because of civil war in that area.

Interviews and collection of plant specimens

Semi-structured interviews were conducted with a number of villagers about their traditional use of plants, such as construction timber, roofing, walling, handicrafts and fiber. First, we organized group meetings with villagers and explained the objectives of our research and consent was obtained before carrying out ethnobotanical survey. The ethical guidelines of the international society of ethnobiology were strictly adhered to (International Society of Ethnobiology 2006). From the initial group meetings, key informants were selected who already have reputation of being specialist in the use of plants for construction, handicrafts and fiber. On the other hand, specialized knowledge of a few "key informants" will likely preclude robust statistical analysis (Hoffman & Gallaher 2007). Therefore, group discussions were also held so as to gain further information on the use of plants and to reinforce the reliability of the data collected through semi-structured interviews. As it is mostly a male dominated work force in the construction and craftsmanship industries in Myanmar, this was subsequently reflected in the male bias of key informants interviewed. A total of 19 key informants were selected for interviews and fieldwork. The age of these informants ranged from 30 to 57 years including only one female informant. All informants grew crops and some of them also raised cattle, chickens and buffalos.

The field surveys were carried out in June-July 2015, February-March 2016 and November-January 2016, and voucher specimens including leaf fragments for DNA analysis were collected. Field sampling at each location was carried out together with an individual from that village to avoid the incorporation of the knowledge from other villagers from elsewhere. The calculated number of useful plants in a given area provided little insight into which species or vegetation types are more important to local people (Phillips et al. 1994). Voucher specimens were deposited in the herbaria of Makino Botanical Garden (MBK), Japan, and Forest Research Institute (RAF), Myanmar.

DNA barcoding

Total DNA was extracted from approximately 20 mg of dried leaf tissue by a CTAB method. PCR amplification of chloroplast *rbcL* region followed the procedure of CBOL Plant Working Group (2009). The rbcLa_F (5'-ATGTCACCACAAACAGAGACTAAAGC-3') and the rbcLa_R (5'-GTAAAATCAAGTCCACCRCG-3') were used as primers. The cycle sequencing was performed using BigDye Terminator v3.1 Cycle Sequencing Kit and ABI 3130 Genetic Analyzer (Thermo Fisher Scientific, Waltham, MA, USA).

Species identification

The Basic Local Alignment Search (Blast) program was used as a tool for searching for the similar DNA sequence from the database of the National Center for Biotechnological Information (NCBI). Among the compared sequences, the species with most similar sequences were used as guidance for species identification. The final identification of specimens was detemined by cross referencing with specimens housed at MBK, as well as the type specimen images on the website of JSTORE Global Plants (https://plants.jstor.org), and online herbarium catalog of the Royal Botanic Gardens, Kew (https://www.kew.org/herbcat/navigator.do). The plant descriptions were consulted in the Flora of China and Flora of Thailand. The scientific names for species are assigned in accordance with The Plant List (http://www.theplantlist.org).

Table 2. List of plant species used for construction and utensil

Taxon	Collection site* and vernacular name	Growth habbit, Wild/Cultivated	Uses	Voucher specimen (TS)
Pinaceae				
Pinus kesiya Royle ex Gordon	M, P: Htin-shu	Tree, Wild	Construction; Craft	47, 671, 115
Arecaceae				
Calamus erectus Roxb.	E: Cane	Herb, Wild	Craft, basket	744
Poaceae				
Bambusa burmanica Gamble	P: Tike-war	Herb, Wild	Construction, post for small hut	654
Bambusa polymorpha Munro	E: Kya-thaung-wa	Herb, Wild	Walling	747
Cephalostachyum pergracile Munro	E: Thin-wa	Herb, Wild	Walling	748
Dendrocalamus calostachyus (Kurz) Kurz	P: War-kyi	Herb, Wild	Construction, walling, flooring	655
Imperata cylindrica (L.) Raeusch.	M: That-kal	Herb, Wild	Roofing; Medicine, rhizome	178
Anacardiaceae				
Anacardium occidentale L.	E: The-ho-tha-yet	Tree, Cultivated	Construction; Fuelwood; Food, seed	828
Lannea coromandelica (Houtt.) Merr.	E: Na-be	Tree, Wild	Construction	853
Mangifera sylvatica Roxb.	E: Taw-tha-yat	Tree, Wild	Construction, flooring; Food, fruits	809
Mangifera indica L.	E, M: Tha-yet	Tree, Cultivated	Construction; Fuelwood; Food, fruit	93, 698, 827, 862
Apocynaceae				
Alstonia scholaris (L.) R. Br.	E: Let-pan-khar	Tree, Wild, Cultivated	Construction; Medicine, bark for carminative, leaf	721, 822
Holarrhena *pubescens* Wall. ex G.Don	E: Lat-htoke-kyi	Tree, Wild	Craft, handle for hole; Medicine	792
Araliaceae				
Eleutherococcus cf. *nodiflorus* (Dunn) S.Y.Hu	P: Tha-yat-kin	Tree, Wild	Construction; flooring; Fuelwood; Food	590
Betulaceae				
Betula utilis D.Don	P: Pan-ma	Tree, Wild	Construction; Fuelwood	652
Bignoniaceae				
Fernandoa adenophylla (Wall. ex G.Don) Steenis	E: Phat-than	Tree, Cultivated	Construction, post; Fuelwood	717, 824
Markhamia stipulata (Wall.) Seem.	E: Ma-lwa	Tree, Wild	Construction; Food, flowers as vegetable	735
Boraginaceae				
Cordia furcans I.M.Johnst.	P: Taw-kha-na, Kyun-pho	Tree, Wild	Construction, door	433, 852
Ehretia dicksonii Hance	P: Kyun-pho	Tree, Cultivated	Construction, door	453

Buseraceae				
Protium serratum (Wall. ex Colebr.) Engl.	E: Kadi	Tree, Wild	Construction, post and beam; Food, fruit	704
Combretaceae				
Anogeissus acuminata (Roxb. ex DC.) Wall. ex Guillem. & Perr.	E: Yone	Tree, Wild	Craft, cart axil	790
Terminalia bellirica (Gaertn.) Roxb.	E: Thit-seint	Tree, Wild	Construction, beam, post, window frame	851
Dipterocarpaceae				
Dipterocarpus costatus C.F.Gaertn.	E: Ka-nyin	Tree, Wild	Construction, furniture, post, beam, rafter and furniture, window and door frame, flooring; Craft; Fuelwood	759
Ebenaceae				
Diospyros montana Roxb.	E: Gyoke	Tree, Wild	Craft, pestle and axe handle	797
Elaeocarpaceae				
Sloanea sigun (Blume) K.Schum.	P: Phet-pyoke	Tree, Wild	Constuction	586
Fabaceae				
Adenanthera pavonina L.	E: Tin-win	Tree, Wild	Construction	758
Albizia chinensis (Osbeck) Merr.	E: Taung-magyi, M: Unknown, P: Sin-sar	Tree, Wild	Construction; Craft, pestle; Fuelwood	76, 587, 639, 802
Albizia julibrissin Durazz.	M: Taunig-ma-gyi	Tree, Wild	Utensil, harrow	150, 317
Dalbergia cultrata Benth.	E, M: Yin-tike	Tree, Wild	Construction	299, 841
Dalbergia lanceolaria L.f.	E: Taunig-ma-gyi	Tree, Wild	Construction, post	767
Erythrina arborescens Roxb.	E, M: Ka-thit	Tree, Wild	Craft, box; Other, fence post	304, 804
Pterocarpus macrocarpus Kruz	E: Padauk	Tree, Wild	Construction, furniture; Craft	741, 799
Fagaceae				
Castanopsis costata (Blume) A.DC.	E: Thit-el	Tree, Wild	Construction, post, harrow, plough, doors and window frame, beam and rafter, walling, flooring; Craft	754
Castanopsis diversifolia (Kurz) King ex Hook.f.	M: Thit-el, P: Phat-kyan, Kyat-sar-ni	Tree, Wild	Construction, furniture, post, beam and rafter, harrow, plough, doors and window frame; Craft; Fuelwood	229, 592, 626
Castanopsis echinocarpa Miq.	M: Thit-el	Tree, Wild	Construction, furniture, post, beam and rafter, roosted seed edible, harrow, plough, doors and window frame; Craft; Fuelwood; Food	48
Castanopsis ferox (Roxb.) Spach	P: Thit-el-kyi	Tree, Wild	Construction, post	661

Castanopsis hystrix Hook. f. & Thomson ex A. DC.	M: Thit-al-thil	Tree, Wild	Construction	146
Castanopsis indica (Roxb. ex Lindl.) A.DC.	P: Thit-el, Thit-al-pote	Tree, Wild	Construction, furniture, posts, beam and rafter, harrow, plough, doors and window frame; Craft; Fuelwood; Food, roasted seed	49
Castanopsis lanceifolia (Oerst.) Hickel & A.Camus	M: Kant-ba-nu, Kan-ba-nu-ni	Tree, Wild	Construction; Craft, cart axil	49, 81, 219/1, 291
Lithocarpus auriculatus (Hickel & A.Camus) Barnett	P: Kyat-sar, Phat-kyan	Tree, Wild	Construction, furniture, post, beam and rafter; Craft; Fuelwood	391, 473, 621
Lithocarpus lindleyanus (Wall. ex A.DC.) A.Camus	M: Thit-al-sein	Tree, Wild	Construction, beam and rafter; Food, roasted seed	240
Quercus franchetii Skan	M: Nyan	Tree, Wild	Craft, cart axil	218
Quercus helferiana A.DC.	M, P: Yin-ku	Tree, Wild	Construction; Fuelwood	87, 216, 265, 537, 659
Juglandaceae				
Engelhardia spicata var. *colebrookeana* (Lindl. ex Wall.) Koord. & Valeton	E: Unknown	Tree, Wild	Construction, post	842
Engelhardia spicata Lesch.ex Blume	M: Ka-di	Tree, Wild	Construction, post	215/1
Lamiaceae				
Gmelina arborea Roxb.	E: Yamanae	Tree, Wild	Construction, beam, rafter, flooring	719, 785
Vitex burmensis Moldenke	P: Pyar-pyar, Pyar-pyar-po	Tree, Wild	Construction; Craft, axe handle	561, 397
Vitex canescens Kurz	E: Kyat-yoe	Tree, Wild	Construction, post, beam, door frame	843
Vitex yunnanensis W.W.Sm.	P: Pyar-pyar	Tree, Wild	Construction; Fuelwood	498, 611
Lauraceae				
Cinnamomum bejolghota (Buch.-Ham.) Sweet	P: Na-lin-kyaw	Tree, Cultivated	Construction, furniture, beam, rafter, door and flooring, table; Craft; Fuelwood; Medicine	375, 581
Litsea glutinosa (Lour.) C.B.Rob.	P: Ohn-ton	Tree, Cultivated	Construction, post, beam, rafter; flooring; Fuelwood	472, 489, 564
Machilus minutiflora (H.W. Li) L. Li, J. Li & H.W. Li	P: Sae-war	Tree, Wild	Construction, Furniture; Craft	457
Persea americana Mill	M, P: Htaw-pat	Tree, Cultivated	Construction, flooring and bar; Food, fruits	195, 377, 404, 542
Phoebe attenuata (Nees) Nees	P: Ohn-ton-ywat-sint	Tree, Wild	Construction	585, 650
Lythraceae				
Duabanga grandiflora (DC.) Walp.	E: Ka-zaw, Thit-ka-zaw	Tree, Wild	Construction, flooring	716, 775, 819
Lagerstroemia tomentosa C. Presl	E: Lel-za	Tree, Wild, Cultivated	Construction, post and beam	701, 825

Lagerstroemia villosa Wall. ex Kurz	E: Zaung-ba-lwe	Tree, Wild	Construction	823
Magnoliaceae				
Magnolia liliifera (L.) Baill.	M,P: Sa-gar	Tree, Wild	Construction, post	144, 634
Malvaceae				
Abroma augusta (L.) L.f.	M: Wet-shaw	Tree, Wild	Tying, bark for fibre	59
Eriolaena kwangsiensis Hand.-Mazz.	M: Phat-wine	Tree, Wild	Constuction, furniture, harrow and plough; Craft	264
Eriolaena spectabilis Planch. ex Mast.	M: Phat-wine	Tree, Wild	Craft, harrow; Tying, bark for fibre	132
Pterospermum acerifolium (L.) Willd.	M: Phat-wine	Tree, Wild	Construction	84
Scaphium scaphigerum(Wall. ex G. Don) G.Planch.	E: Shaw-phyu	Tree, Wild	Tying, bark for fibre	788
Sterculia villosa Roxb.	E: Shaw	Tree, Wild	Tying, bark for fibre	573, 863
Meliaceae				
Heynea trijuga Roxb. ex Sims	P; Kyat-ma-oat	Tree, Wild	Construction, flooring	647
Melia azedarach L.	P: Khun	Tree, Wild, Cultivated	Construction, beams and window frame	384, 520
Toona sinensis (Juss.) M.Roem	P: Thit-pote	Tree, Wild	Construction, window frame and leave	539
Toona sureni (Blume) Merr.	P: Mel-yone	Tree, Wild, Cultivated	Construction, furniture, beam, rafter, window and door, ladder; Craft	337, 373, 428, 455, 503, 584, 601
Moraceae				
Artocarpus altilis (Parkinson ex F.A.Zorn) Fosberg	E: Taung-pain-hnel	Tree, Wild	Construction, post, beam and rafter and flooring	808
Artocarpus chama Buch.-Ham.	E: Taung-pain-hnel	Tree, Wild	Construction, beam, rafter and flooring	740
Myrtaceae				
Syzygium oblatum (Roxb.) Wall. ex A.M.Cowan & Cowan	E: Tha-pyay	Tree, Wild, Cultivated	Construction, furniture, beam, post, fafter and door frame, window frame; Craf;, Food, fruits	83, 134, 253, 460, 509, 572
Syzygium pycnanthum Merr. & L.M.Perry	M, P: Tha-pyay	Ttee, Wild	Construction, beam, post, rafter and door frame, window frame; Craft; Fuelwood; Food, fruit	104, 615
Syzygium cumini (L.) Skeels	E: Tha-pyay, M: Tha-pyay, Tha-pyay-kyan	Tree, Wild	Construction, furniture, feam, post, rafter and door frame, window frame; Craft; Food, fruit	215, 228, 838
Olacaceae				
Anacolosa clarkii Pierre	M: Khwe-ohn	Tree, Wild	Craft, box	244
Oleaceae				
Fraxinus floribunda Wall.	P: Pyar-pyar-pho	Tree, Wild	Craft, axe handle, cart-yoke; Fuelwood	604
Olea salicifolia Wall. ex G.Don	E: Hun-nain	Tree, Wild	Construction, post	834
Phyllanthaceae				
Glochidion nubigenum Hook.f.	M, P: Fuso	Small Tree, Wild	Fuelwood; Others, post for agrculture	103, 431

Pittosporaceae				
Pittosporum kerrii W. G. Craib	P: Yae-nin	Tree, Wild	Construction, furniture, flooring	467
Pittosporum napaulense (DC.) Rehder & E.H. Wilson	P: Yae-nin	Tree, Wild	Construction, furniture, flooring; Craft; Fuelwood	380, 648
Rhamnaceae				
Ziziphus incurva Roxb.	P: Sue-kaut	Tree, Wild	Construction, post, door and wind frame; Fuelwood; Food, fruits	398, 469, 583, 688
Rosaceae				
Eriobotrya japonica (Thunb.) Lindl.	P: Thit-kya-pwea	Tree, Wild, Cultivated	Construction, bean and rafter	559, 612
Prunus cerasoides Buch.-Ham. ex D.Don	P: Cherry, Thein-chin	Tree, Cultivated	Construction, furniture, hoe-handle, door and window frame, beam and rafter; Craft; Fuelwood; Ornamental	356, 376, 454, 511, 516, 589, 649
Rubiaceae				
Tarennoidea wallichii (Hook.f.) Tirveng. & Sastre	P: Thit-ka-pike	Tree, Wild	Construction, furniture, beam and rafter; Craft; Fuelwood	580, 646
Wendlandia budleioides Wall. ex Wight & Arn.	M: Thit-ne	Tree, Wild	Construction; Food, leaf for salad	85
Wendlandia tinctoria (Roxb.) DC.	M: Thit-ni	Tree, Wild	Construction	273
Sabiaceae				
Meliosma arnottiana (Wight) Walp.	P: Thit-su	Tree, Wild	Construction, flooring	594, 602
Salicaceae				
Casearia graveolens Dalzell	E: Phan-khar	Tree, Wild	Construction, post; Food, fruit	801
Homalium bhamoense Cubitt & W.W.Sm.	E: Myauk-chaw	Tree, Wild	Construction	821, 844
Xylosma controversa Clos	P: Sue-ni	Tree, Cultivated	Construction	510, 525
Xylosma longifolia Clos	P: Swae	Tree, Wild	Construction, post	622
Sapindaceae				
Nephelium chryseum Blume	M: Thit-ni	Tree, Wild	Construction	111
Staphyleaceae				
Turpinia pomifera (Roxb.) DC.	M: Chae-da-yat	Tree, Wild	Construction	263
Theaceae				
Schima wallichii Choisy	M, P: Thit-yar	Tree, Wild, Cultivated	Construction, post, beam and rafters; Craft; Food; Medicine	86, 102, 145, 208, 426, 528, 633, 214/1

*: E, Eden; M, Myin Ka; P, Pin-sin-pin.

4. Results and Discussions

A total of 93 species from 38 families was recorded as plant resources for construction, handicrafts and fiber. Among these, 16 species was cultivated in home garden or on a larger scale in farmland. As many of the vouchers collected were of sterile plants, DNA barcoding techniques facilitated and enhanced the accuracy of the identification of these samples. Fagaceae was the most dominant family with largest number of species (11 species) followed by Fabaceae (7 species), Lauraceae and Poaceae (5 species each). Ethnobotanical data such as vernacular names, collection localities and traditional uses are listed in Table 2 and the frequency of uses for each species is listed in Table 3.

A number of specific uses recognized in this study are listed in Table 4. A few of the most commonly used tree species had multiple uses, but among the tree species used with medium frequency, some had very specialized uses restricted to one particular application. For example, *Toona sureni* (P) was prefered wood for ladders, the stem of *Fraxinus floribunda* (P) for cart yokes, the leaves of *Imperata cylindrica* (M) for roofing, and *Calamus erectus* (E) for basket weaving.

Some exotic species, *Anacardium occidentale* (E) and *Persea americana* (M, P) were also cultivated in farmlands and home gardens. Seeds of *Anacardium occidentale* and fruits of *Persea americana* were important cash crops for the villagers. The wood of these two species is also used as timber for flooring and construction.

Plant species used in each village

In total, 38, 30, 39 plant species were documented for Eden, Myin Ka and Pin-sein-pin Village respectively (Fig 2). Only one species, *Albizia chinensis* was used in all three villages. However, the mode of utilization for this species was different; for making pestle in Pin-sein-pin Village, but for construction purposes in other two villages. Myin Ka Village shared nine species with Pin-sein-pin Village and only five species with Eden Village. There were more commonly used shared species between Myin Ka and Pin-sein-pin villages than there were between Myin Ka and Eden villages. The reason for this could be due to the differences in forest type around each village. The forest type around Eden Village is deciduous whereas the forests surrounding Myin Ka and Pin-sein-pin Villages are evergreen. There was also an observed difference in the selection of preferred utilized species between three villages. For example, the more preferred species for construction in Myin Ka and Pin-sein-pin were *Castanopsis diversifolia* and *Schima wallichii*, whereas the most preferred species for construction in Eden was *Syzygium oblatum*.

Plants used for construction

The villagers reported a variety of different uses of timber for construction such as posts, beams, rafters, door and window frames, door and window panels, and flooring etc. The wood of 76 species is used for construction purposes, including one bamboo species, the stem of which used as post for construction of hut. The most frequently used plants are *Castanopsis diversifolia* (M, P), *Schima wallichii* (M, P), *Syzygium cumini* (E, M), *Syzygium oblatum* (E), *Prunus cerasoides* (P), *Castanopsis costata* (E), *Castanopsis indica* (P),

Castanopsis echinocarpa (M), *Syzygium pycnanthum* (M,P), *Toona sureni* (P) and *Quercus helferiana* (M, P).

Castanopsis diversifolia (M, P) and *Schima wallichii* (M, P) were the most frequently used plants for posts, beams, rafters, and door and window frames. *Pterocarpus macrocarpus* (E) is also one of the most sought after timber species in Myanmar for both construction and furniture making. *Toona sureni* (P) was used for ladders because of its attractive red colour and fine texture (Fig 3A). *T. sureni* (P) is considered high-value wood due to it being easy to saw and to work. Djam'an (2003) reported that it is used for high-class cabinets, furniture making, interior finishing, decorative paneling, crafts, musical instruments, cigar boxes, veneer and for construction. It is also known as Indonesian Mahogany in the timber market (Parvin et al. 2012). The growth of *T. sureni* (P) was very suitable against windy stress up to 20 meters height. Therefore, the trees were used as a windbreak in the tea plantation at Pin-sein-pin Village. This kind of traditional practice should be encouraged as a sustainable agroforestry system. Thus, this species has an excellent potential for economic development in the region.

Three bamboo species, *Bambusa polymorpha* (E), *Cephalostachyum pergracile* (E) and *Dendrocalamus calostachyus* (P) were identified as being used for roofing and walling. *D. calostachyus* is also used for flooring (Fig 3B). The leaves of *Imperata cylindrica* are used for thatching (Fig 3C). Although bamboo is frequently used for walls and partitions, the use of thatch and bamboo as roofing materials become less frequent in the study area (Fig 3D). The wood of five tree species, *Castanopsis costata* (E), *Castanopsis diversifolia* (M, P), *Castanopsis echinocarpa* (E), *Castanopsis indica* (P) and *Duabanga grandiflora* (E) was identified as being used for constructing walls.

Some of the plants species have multiple uses, such as for medicine and food. *Mangifera indica* (E, M) is a common home garden plant for edible fruit throughout Myanmar. Decoction of the bark from *Alstonia scholaris* (E) and *Holarrhena pubescens* (E) is locally used as a remedy for carminative and diarrhea respectively. Various biological and pharmacological activities have been reported for *A. scholaris* (Khyade et al. 2014). The antibacterial properties from the bark extract of *H. pubescens* have been reported (Chakraborty & Brantner 1999).

Table 3. Frequency of use for each species from 19 key informants

Taxon	Family	Collection site*	Const-ruction	Roof and wall	Craft	Tying	Sum
Castanopsis diversifolia	Fagaceae	M, P	10	1	3	0	14
Schima wallichii	Theaceae	M, P	10	0	3	0	13
Prunus cerasoides	Rosaceae	P	7	0	5	0	12
Syzygium cumini	Myrtaceae	E, M	9	0	1	0	10
Castanopsis costata	Fagaceae	E	7	1	1	0	9
Castanopsis echinocarpa	Fagaceae	M	7	1	1	0	9
Castanopsis indica	Fagaceae	P	7	1	1	0	9
Syzygium oblatum	Myrtaceae	E	8	0	0	0	8
Syzygium pycnanthum	Myrtaceae	M, P	7	0	0	0	7
Toona sureni	Meliaceae	P	6	0	1	0	7
Dipterocarpus costatus	Dipterocarpaceae	E	5	0	2	0	7
Quercus helferian	Fagaceae	M, P	6	0	0	0	6
Pittosporum napaulense	Pittosporaceae	P	3	0	3	0	6
Protium serratum	Buseraceae	E	5	0	0	0	5
Persea americana	Lauraceae	M, P	5	0	0	0	5
Dendrocalamus calostachyus	Poaceae	P	3	2	0	0	5
Pinus kesiya	Pinaceae	M, P	3	0	2	0	5
Castanopsis lanceifolia	Fagaceae	M	2	0	3	0	5

*: E, Eden; M, Myin Ka; P, Pin-sin-pin.

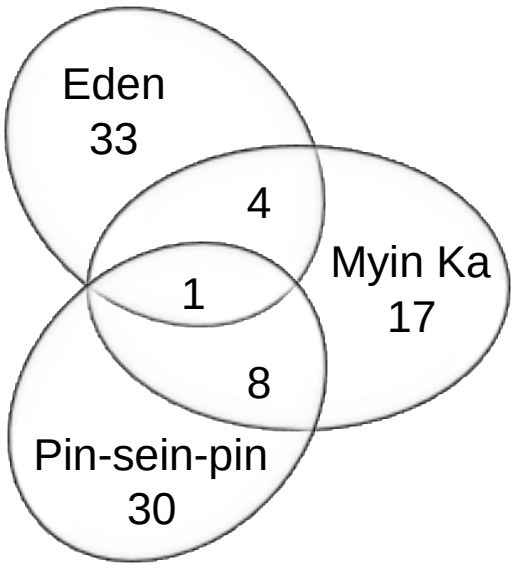

Figure 2. Number of species used in each village.

Plants used for traditional handicrafts

The villagers reported using plants to construct handicrafts such as harrows, ploughs, axe handles, hoe handles, boxes, baskets, furniture, fence posts, cart yokes and cart axles (Fig 3E). The most frequently used species for these handicrafts are *Prunus cerasoides* (P), *Castanopsis diversifolia* (M, P), *Schima wallichii* (M, P), *Pittosporum napaulense* (P), *Castanopsis lanceifolia* (M) and *Fraxinus floribunda* (P).

Calamus erectus (E) was used for making various types of baskets. The use of rattan baskets for carrying food and fuel wood is still very common in the area. *Anogeissus acuminata* (E) and *Castanopsis lanceifolia* (M) were used as cart axles due to their strength and durability. *Castanopsis diversifolia* (M, P) was used for furniture and ploughs (Fig 3F). The wood of *Fraxinus floribunda* (P) was used only for axe handles and cart yokes. *Albizia chinensis* (E, M, and P) was specially used as mortar and pestle in Pin-sein-pin Village (Fig 3G). The wood of *Holarrhena pubescens* (E) was used for hoe handles.

Plants used for fiber

Only four species from the family of Malvaceae, *Sterculia villosa (E), Scaphium scaphigerum (E), Abroma augusta* (M) and *Eriolaena spectabilis* (M) were identified as being used for plant fiber. However, the villagers reported that plant fiber has become less preferable because of the increasing availability of plastic ropes from the market.

Figure 3. A. Ladder made from the wood of *Toona sureni*. **B**. Preparing for bamboo floor with *Dendrocalamus calostachyus*. **C**. Thatch preparing with *Imperata cylindrica*. **D**. Brick-knocking style building in Pin-sein-pin Village. **E**. Crafts made of wood and bamboo are essential in rural livelihood. **F**. A common plough made from the wood of *Castanopsis species*. **G**. Mortar and pestle made from the wood of *Albizia chinensis*.

Table 4. Specific uses and prefer speceies

Type of use	Most used species
Construction	
Beam	*Castanopsis diversifolia, Schima wallichii*
Door and window frame	*Castanopsis diversifolia, Syzygium cumini*
Door and window panel	*Toona sinensis*
Flooring	*Castanopsis costata, Dipterocarpus costatus*
Ladder	*Toona sureni*
Post	*Castanopsis diversifolia, Schima wallichii*
Rafter	*Castanopsis diversifolia, Schima wallichii*
Craft	
Axe handle	*Fraxinus floribunda, Vitex burmensis*
Basket	*Calamus erectus*
Cart axil	*Castanopsis lanceifolia, Anogeissus acuminata*
Cart yoke	*Fraxinus floribunda*
Furniture	*Prunus cerasoides, Dipterocarpus costatus*
Harrow	*Castanopsis diversifolia, Eriolaena kwangsiensis*
Hoe handle	*Prunus cerasoides*
Pestle	*Albizia chinensis, Diospyros montana*
Plough	*Castanopsis diversifolia, Albizia julibrissin*
Walling and roofing	
Roofing	*Imperata cylindrica*
Walling	*Bambusa polymorpha, Cephalostachyum pergracile*
Tying	
Fibre	*Sterculia villosa, Scaphium scaphigerum*
Others	
Post for agricultre	*Glochidion nubigenum*
Post for fence	*Erythrina arborescens*

5. Conclusion

The results of this study indicate that plant resources are very important in meeting the basic needs of local communities especially for shelter and daily utensils. A rich diversity of plants as a source for construction material, handicrafts and fiber has been documented in this study. The local communities are using diverse plant species for different use categories. The accumulated body of traditional knowledge about plants can improve the economic value of the plant resources available to the local community. This kind of traditional knowledge is very important for the sustainable use of plant resources. However, the diminishing use of plant resources has also been observed in the study area due to the availability of substitutes, such as plastic ropes from the markets.

The majority of species (83%) are still extracted from the wild for subsistence uses. Tree species, which were more frequently used, were identified through this study and this knowledge could be used to address the conservation issues of the surrounding natural forests. To help reduce the pressure on the natural resources from surrounding forests, high priority should be given to plant heavily utilized and high demand timber species in home gardens and in farmland to encourage the sustainable utilization of plant resources.

The traditional ethnobotanical knowledge of local communities should be considered for *in-situ* biological conservation programs since the biological, cultural and ethnobotanical diversity are all threatened in Shan State. Conservation programs should be incorporated that prioritise the protection of natural resources by encouraging traditional activities that take into consideration the local knowledge of plants.

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