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Original Paper

The *ex situ* Conservation of Legume Genetic Resources in the Southern Shan State of Myanmar in 2018

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Summary

This report presents the findings of the collaborative survey between Myanmar and Japan for the *ex situ* conservation of legume genetic resources in the southern Shan State of Myanmar from November 11 to 23 in 2018. In this survey, we concentrated on the *ex situ* conservation of crop wild relatives of the genus *Vigna*. We collected a total of 31 seed samples and recorded three immature wild *Vigna* population sites from where no seed samples could be collected. Collected seed samples consisted of one accession each of *Glycine max*, *Phaseolus vulgaris*, and *Pisum sativum*; four of wild *Vigna angularis*; seven of wild *Vigna hirtella* species complex; four of wild *Vigna minima*; five of wild *Vigna tenuicaulis*; one each of wild *Vigna umbellata* and intermediate *Vigna umbellata*; two of *Vigna unguiculata*; and four of unidentified wild *Vigna* species (*Vigna* sp.). The unidentified wild *Vigna* species might be candidates for a new taxon. The seeds have been conserved in the Department of Agricultural research seed bank in Myanmar, and a subset was transferred to the National Agriculture and Food Research Organization (NARO) Genebank in Japan under the Standard Material Transfer Agreement of the International Treaty on Plant Genetic Resources for Food and Agriculture. After the seeds collected in this survey are multiplied, the NARO Genebank plans to conserve them as distributable genetic resources for research, breeding, and training purposes for food and agriculture.

KEY WORDS: crop wild relatives, genetic resources, legume, *Vigna*

Introduction

Conservation of crops and their wild relatives is one of the most important roles assigned to plant gene banks. In recent years, crop wild relatives have received considerable attention (Castañeda-Álvarez *et al.* 2016) because some of them are known to be tolerant or resistant to environmental or biological stresses. Therefore, the National Agriculture and Food Research Organization (NARO) Genebank has been collecting crop wild relatives of *Vigna* crops, including cowpea (*Vigna unguiculata* (L.) Walp.), azuki bean (*Vigna angularis* (Willd.) Ohwi & Ohashi), and rice bean (*Vigna umbellata* (Thunb.) Ohwi & Ohashi) (Tomooka *et al*. 2010).

Since 2010, no new species of *Vigna* have been described in any Southeast Asian countries. Conversely, six new species have been described in India (Dixit *et al.* 2011; Aitawade *et al.* 2012; Gaikwad *et al.* 2014; Latha *et al.* 2014; Gaikwad *et al.* 2015; Balan *et al.* 2017). Genus *Vigna* can be found from the tropical to temperate zones and is divided into five subgenera: *Ceratotropis*, *Haydonia*, *Lasiospron*, *Plectrotropis*, and *Vigna*. The subgenus *Ceratotropis* is further divided into three sections: *Angulares*, which includes azuki bean and rice bean; *Ceratotropis*, which includes mungbean (*Vigna radiata* (L.) Wilczek) and black gram (*Vigna mungo* (L.) Hepper); and *Aconitifoliae*, which includes moth bean (*Vigna aconitifolia* (Jacq.) Marechal). The diversity center of the subgenus *Ceratotropis* is South Asia and Southeast Asia, with high number of *Ceratotropis* species found in Myanmar, which is second only to those found in India (Tomooka *et al.* 2011).

This report presents the findings of a collaborative survey of legume genetic resources in the southern Shan State of Myanmar. Myanmar is a very large country, ranging from the southern coastal area to the northern mountainous area, including the highest peak of Southeast Asia—Mt. Hkakabo Razi (5,881 m). Hence, large regional differences exist in temperature and precipitation (http://themimu.info/node/64591). The southern coastal area, including Yangon, is classified as a tropical monsoon climate (Am) according to Köppen; this area includes regions having annual precipitation exceeding 5,000 mm. Conversely, a dry inland area, including Mandalay, has annual precipitation below 1,000 mm. This dry inland area is classified as steppe climate (BSh). The northern mountainous areas, including Chin State, Sagain Region, Kachin State, and Shan State, are classified as temperate dry winter climates (Cw) with some snowfall. In the present survey, we visited the southern Shan State from the end of rainy season (summer) to the beginning of dry season (winter). This is the season of rice harvesting.

Methods

We conducted a field survey in the southern Shan State of Myanmar from November 11 to 23 in 2018, based on the memorandum of understanding between the NARO Genebank of Japan and the Department of Agricultural Research (DAR) seed bank of Myanmar (Table 1, Fig. 1). We interviewed landowners and asked for their permission to collect seeds from the owners' stocks and wild leguminous plants growing on their land. We recorded the passport data, including the latitude, longitude, and altitude, by using Google Earth (Google Inc.). The wild *Vigna* species were identified on the basis of taxonomic keys (Tomooka *et al.* 2002; Maxted *et al.* 2004).

Results and Discussion

We collected a total of 31 accessions consisting of one accession each of soybean (*Glycine max* (L.) Merr.), common bean (*Phaseolus vulgaris* L.), and garden pea (*Pisum sativum* L.); four of wild *V. angularis*; seven of wild *Vigna hirtella* Ridley species complex; four of wild *Vigna minima* (Roxb.) Ohwi & Ohashi; five of wild *Vigna tenuicaulis* N. Tomooka & Maxted; one wild and one intermediate form of *V. umbellata*; two of cowpea (*V. unguiculata*); and four of unidentified wild Vigna species (*Vigna* sp.; Table 2). Half of the collected seeds were conserved in the DAR seed bank, and the remaining were transferred to

Table 1. Itinerary of the field survey in southern Shan State, Myanmar, 2018

Date	Itinerary	Stay (City or Town)
11-Nov	Narita - JL717 - Bangkok - JL5981 - Naypyidaw - Yezin	Yezin
12-Nov	Yezin (visit DAR seed bank)	Yezin
13-Nov	Yezin - Taunggyi	Taunggyi
14-Nov	Taunggyi - Loilem - Nansang	Nansang
15-Nov	Nansang - Kengtung	Kengtung
16-Nov	Kengtung - Tachileik	Tachileik
17-Nov	Tachileik - Kengtung	Kengtung
18-Nov	Kengtung - Taunggyi	Taunggyi
19-Nov	Taunggyi - Aungban	Aungban
20-Nov	Aungban - Kalaw - Yezin	Yezin
21-Nov	Yezin (visit DAR seed bank)	Yezin
22-Nov	Yezin - Yangon	Yangon
23-Nov	Yangon - JL5952 - Bangkok - JL718 - Narita	-

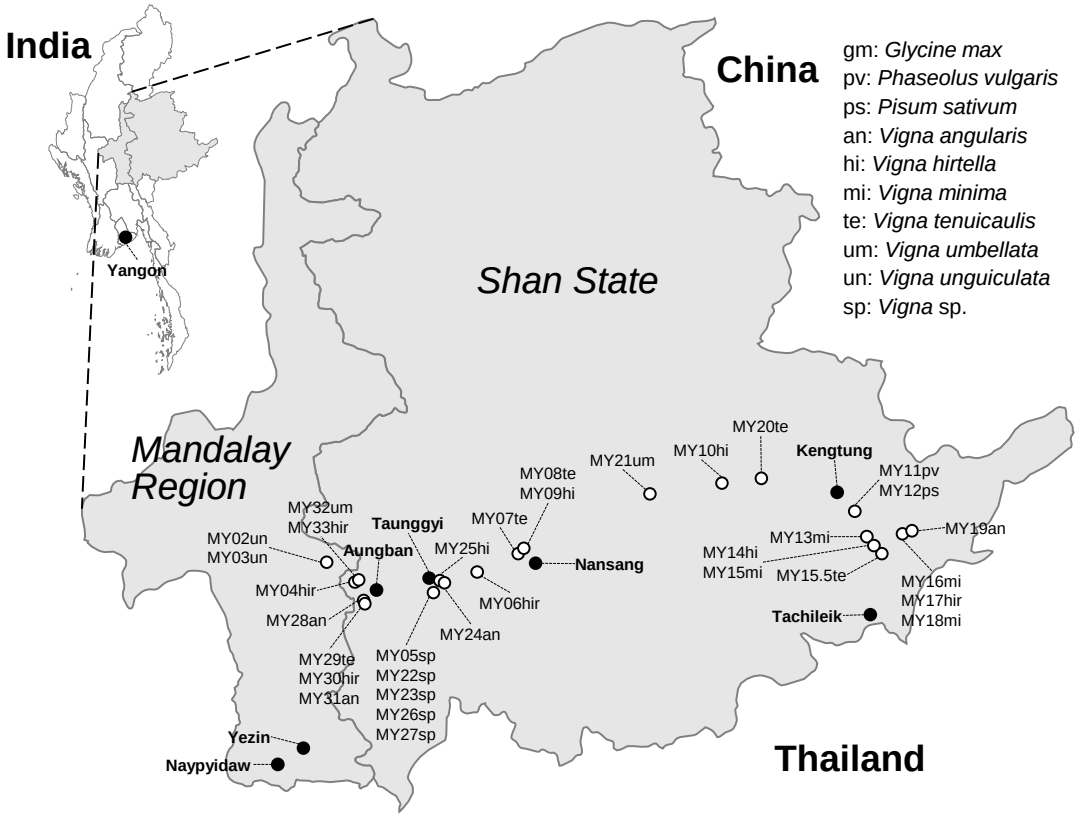

Fig. 1. Map showing the collection sites (white circle) and the major cities (black circle). Two characters after the collection number indicate plant ID abbreviation of the scientific name shown in the upper right legend.

Table 2. Summary of the collected materials and recorded habitats

Scientific name	Status			No. of seed samples collected	Habitat recorded (No seeds collected)	Total
	Wild	Intermediate	Domesticated			
Glycine max	-	-	1	1	-	1
Phaseolus vulgaris	-	-	1	1	-	1
Pisum sativum	-	-	1	1	-	1
Vigna angularis	4	-	-	4	-	4
Vigna hirtella	7	-	-	7	2	8
Vigna minima	4	-	-	4	-	4
Vigna tenuicaulis	5	-	-	5	-	6
Vigna umbellata	1	1	-	2	-	2
Vigna unguiculata	-	-	2	2	-	2
Vigna sp.	4	-	-	4	1	5
Total	25	1	5	31	3	34

the NARO Genebank under the Standard Material Transfer Agreement. In addition, two natural habitats of *V. hirtella* and one natural habitat of *Vigna* sp. were recorded (Table 2). The passport data of each accession are shown in Table 3. The characteristics of each species are described below.

Unidentified wild *Vigna* species (*Vigna* sp.)

We found some unidentified wild *Vigna* species that could not be classified as any previously described species of the genus *Vigna*. They were growing on the outskirts of Taunggyi, the capital of Shan State. Their habitats were an open hilly area with limestone rocks (Photos 1 and 2). The populations were recorded at altitudes ranging from 1,552 to 1,582 m above sea level.

We classified the unidentified wild *Vigna* species in subgenus *Ceratotropis* because it had yellow flowers, a curled keel of more than 160° to the left, and peltate stipules. The plants were considered to be in section *Angulares* based on their smooth seed coat and hairless pods (Photo 3, Seed photos MY05, MY22, MY23, MY26, and MY27). The plants were morphologically most similar to the wild ancestor of rice bean (*V. umbellata*), especially in their seed morphology, having prominently protruding seed hilum at the center of the seed (Seed photos MY21 and MY32). However, the plants differed from wild *V. umbellata* in the following morphology: ovate smaller leaflets, fewer flower buds per inflorescence, and shorter peduncles and pods (Photo 3). In addition, the plants showed a unique ability to form inflorescences from the underground stems and stems near the soil surface (Photos 4 and 5).

We believe that the plants might be treated as a novel taxon either at the species, subspecies, or variety level. To clarify the distinctness at the molecular level, we intend to sequence the nuclear and chloroplast DNA of the barcode regions and draw phylogenetic trees for comparison with other related *Vigna* species.

***Vigna angularis* (Willd.) Ohwi & Ohashi var. *nipponensis* (Ohwi) Ohwi & Ohashi in J. Jap. Bot. 44:29 (1969): Wild ancestor of azuki bean:**

This taxon is a wild ancestor of azuki bean (*Vigna angularis* (Willd.) Ohwi & Ohashi). The natural habitat of this taxon coincides with the laurel forest zone, which extends from northern India to Nepal, Bhutan, southern China, and Japan (Tomooka *et al*. 2002). Because this species prefers lower temperatures than those of other related *Vigna* species, its geographical distribution extends to higher latitudes in

temperate regions. They grow at higher altitude habitats in tropical countries at lower latitudes. One of the remarkable diagnostic characters is that its secondary bract becomes sufficiently large to cover the young flower bud (Tomooka *et al*. 2002).

The sample 2018MY24 was collected at an altitude of 1,652 m in Taunggyi (Photo 6). The collection site was along a mountain road on the way to "Shwe Phone Pwint Pagoda" (Photo 7). We identified 2018MY24 as *V. angularis* because of its large secondary bract (Photo 8). In addition, wild azuki bean was growing on an embankment of a paddy field (2018MY28) and alongside a train track (2018MY31) in Kalaw. All populations consisted of a few individuals occupying a very small area.

The sample 2018MY19 was identified as *V. tenuicaulis* at the collection site. This population was growing at a relatively low elevation (859 m) along the mountain road to Mongyawng, located on southeast of Kengtung. Based on the morphological observation of the last author (N. T.) during seed multiplication at Tsukuba in 2019, we re-identified it as *V. angularis*. However, it also showed similarity to *V. tenuicaulis*, and was thus treated as cf. *V. angularis* in this study (Table 3).

The geographical distribution of wild azuki bean suggests that it is the only species in the subgenus *Ceratotropis* that has adapted to a region with the lowest temperature. Wild azuki bean JP226665 was only found at the southernmost site; it was collected from Xam Nua, Laos, (latitude, 20.215917; longitude, 103.966889; altitude, 1,370 m; 2005L34 in Tomooka *et al.* 2006). In Myanmar, wild azuki bean was collected from Chin State (Tomooka *et al.* 2003), Sagain Region (Domon *et al.* 2015; Naito *et al.* 2017), and Kachin State (Watanabe *et al.* 2007). To our knowledge, this is the first record of wild azuki bean from Shan State.

***Vigna tenuicaulis* N. Tomooka & Maxted in Kew Bull. 57(3):613-624 (2002): Wild relative of azuki bean**

Vigna tenuicaulis is the most closely related species to wild azuki bean. In general, it has a smaller organ size and shorter secondary bract than those of wild azuki bean (Tomooka *et al*. 2002). In the southern Shan State, this species was generally found along roadside grassland and on flooded paddy field embankments (Photos 9 and 10). Its habitat ranged from 484 m to 1,338 m in altitude, and six accessions were collected (Tables 2 and 3). At the railway side grassland habitat in the southern part of Kalaw, three wild *Vigna* species, i.e., *V. angularis*, *V. hirtella* species complex, and *V. tenuicaulis*, were growing sympatrically. We identified *V. tenuicaulis* based on their smaller vegetative organs and shorter pod length. We attempted to collect the seeds of each species separately and designated them 2018MY29 (*V. tenuicaulis*), MY30 (*V. hirtella* species complex), and MY31 (*V. angularis*). Morphological observation during seed multiplication in 2019 at Tsukuba, Japan, by last author (N. T.) revealed that the seeds of *V. angularis* and *V. tenuicaulis* seemed to be mixed in MY29 and MY31; hence, the seed photo of these two accessions might contain seeds of two other species (seed photos MY29 and MY31). We intend to collect seeds of each species separately from MY29 and MY31 and re-construct MY29 (*V. tenuicaulis)* and MY31 (*V. angularis*) accessions.

At the collection site of 2018MY07, a monk (Mr Su May Thar) informed us that "This plant is called 'Pha Kala Mom' and you can sleep well if you have a cup of tea made from its decoction" (Photos 11 and 12). Azuki bean, which is the most closely related to V. tenuicaulis, is traditionally used as an anti-inflammatory and a diuretic agent in China and Japan. However, no scientific study on the sedative effects of azuki beans or related species has yet been conducted. Since 13 flavonoidal derivatives having strong

radical scavenging activities were extracted from azuki bean (Hori *et al.* 2009), research on its functional ingredients has attracted considerable attention.

***Vigna umbellata* (Thunb.) Ohwi & Ohashi in J. Jap. Bot. 44:31 (1969): Wild rice bean**

This species includes domesticated rice bean and its wild ancestor. The natural habitat of wild *V. umbellata* is mainly in Southeast Asia (Tomooka *et al.* 2002), but it has also migrated and naturalized in the Americas (https://www.naturalista.mx/taxa/291751-Vigna-umbellata). This species is distinguishable from *V. hirtella* species complex by having a more prominent seed hilum and from *V. minima* by having a larger stipule (Tomooka *et al.* 2002).

Sample 2018MY21 was collected from a lakeside (Photo 13). We identified it as a wild ancestor of rice bean, because of the bright yellow flowers, long inflorescence with many flower buds (Photo 14), large stipule (Photo 15), smaller seeds than its domesticated form, and protruding seed hilum (Seed photo MY21). Conversely, since 2018MY32 has larger seeds, we considered it as a hybrid-derived intermediate form between domesticated and wild rice bean.

In this survey, we also found some other domesticated or wild rice beans on farms and along roadsides. However, these populations were still at the flowering stage, and no mature pods could be collected. In order to collect seeds of this species in this area, exploration needs to be conducted in December.

***Vigna hirtella* species complex: cf. *Vigna hirtella* Ridley in J. Fed. Mal. States Mus. 10:132 (1920): Wild relative of rice bean**

Chankaew *et al.* (2014) revealed that the collections conserved as *V. hirtella* in the NARO Genebank could be divided into three groups by using molecular phylogenetic analysis with single sequence repeat markers; hence, they identified them as *V. hirtella* species complex in this study. The first group that was marked *V. hirtella* "a1" in Chankaew *et al.* (2014) was found at relatively lower altitude areas, generally below 600 m, in Southeast Asia. This group was named "*V. hirtella* lowland type" in this study. The second group that was marked *V. hirtella* "a2" in Chankaew *et al.* (2014) was distributed in northern Southeast Asian mountain areas, generally over 1,000 m altitude. This group was named "*Vigna hirtella* mountain type" in this study. The third group that was marked *V. hirtella* "b" in Chankaew *et al.* (2014) was likely a misidentification of *V. tenuicaulis* as well as the probable hybrid derivative between *V. tenuicaulis* and its related species such as *V. hirtella*, *V. angularis*, and *V. minima*.

All the collections registered as *V. hirtella* in NARO Genebank passport database in this study are considered to belong to the second group *V. hirtella* mountain type (Table 3). The altitude of the collections ranged from 541 m to 1,701 m. At present, we are conducting morphological and molecular studies to resolve the taxonomic issues associated with *V. hirtella* species complex.

At some collection sites in this survey, *Vigna hirtella* mountain-type plants sympatrically inhabited with *V. tenuicaulis* (Photo 16); thus, we could compare the morphology of both plants growing under the same conditions. Unlike 2018MY08 (*V. tenuicaulis*), 2018MY09 (*V. hirtella* mountain type) was characterized by its inflorescence with more flower buds (Photos 17 and 18), longer pods (Photos 19 and 20), larger leaflets (Photos 21 and 22), and a later flowering time. Many mature pods were harvested from 2018MY10, but only one yellowish pod was collected from 2018MY09.

Because *V. hirtella* species complex is cross-compatible with *V. tenuicaulis* and *V. angularis*

(Tomooka *et al.* 2002), determining whether hybrid plants were included in the collection of the present survey is necessary (e.g., MY29, MY30, and MY31; collection site, Kalaw where *V. hirtella* mountain type, *V. angularis*, and *V. tenuicaulis* plants were also found). In addition, we believe that this area needs to be surveyed in December in order to collect seeds from *V. hirtella* mountain type and *V. umbellata*, since they are late maturing species.

***Vigna minima* (Roxb.) Ohwi & Ohashi in J. Jap. Bot. 44:30 (1969): Wild relative of rice bean**

This species showed a remarkable genetic variation in Cambodia. Takahashi *et al.* (2014, 2015) found various morphological variations among accessions collected from various environmental habitats related to water status such as dry sandy habitat or wet marshy habitat, light conditions such as dark forest floor habitat or open floodplain habitat, and temperature regimes such as high-temperature lowland habitat or low-temperature mountain habitat. Morphological variations in leaflet shape; leaf and seed size; and pigment of seed, stem, flower, and pod were high.

Sample 2018MY13 was found on a roadside slope with exposed rocks and running water (Photo 23). Seeds of *V. minima* were morphologically similar to those of *V. umbellata*, but *V. minima* was distinguishable from *V. umbellata* by its smaller leaflets and considerably smaller stipule and bracteole (Photos 24 and 25). Furthermore, 2018MY15 was found on a relatively dry roadside slope, where 2018MY14 (*V. hirtella* mountain type) was also found in an adjacent wet place beside a stream with stagnating water from the mountain (Photo 26). 2018MY18 sympatrically inhabited with 2018MY17 (*V. hirtella* mountain type) along the mountain roadside together with bamboos (Photo 27). In this survey, this species was collected at an altitude of 794 m or less, i.e., it was found in a place lower than the distribution range of the other species (Table 3).

***Vigna unguiculata* (L.) Walp., Rep. Bot. Syst. I:779 (1842): Cowpea and yardlong bean**

Vigna unguiculata was classified in the subgenus *Vigna* (Maxted *et al*. 2004), and its cultigen was domesticated from its wild ancestor (*V. unguiculata* (L.) Walp. subsp. *dekindtiana* (Harms) Verdc.) in Africa (Ng and Marechal 1985). This cultigen is divided into four cultivar groups, and three of them are cultivated in Asia: *V. unguiculata* (L.) Walp. cv-gr. Unguiculata E. Westphal for dry beans, *V. unguiculata* (L.) Walp. cv-gr. Biflora E. Westphal with small seeds and short pods, and *V. unguiculata* (L.) Walp. cv-gr. Sesquipedalis E. Westphal for vegetable called as yardlong bean (Pasquet 1998).

We were kindly provided cowpea and yardlong bean seeds by a farmer we first visited in this survey. Sample 2018MY02 was cowpea used as a dry bean called "Pae Na Daw," which means the bean grown in December (Photo 28). Sample 2018MY03 was yardlong bean used as a vegetable called "Tai Htaung Pae," which means the bean that climbs (Photo 29). The farmer cultivated these *Vigna unguiculata* together with rice bean (*V. umbellata*), velvet bean (*Mucuna pruriens* L. DC. var. *utilis* (Wall. ex Wight) L. H. Bailey), and yam bean (*Pachyrhizus erosus* (L.) Urb.) in a backyard banana plantation.

Other legumes

We bought soybean (*G. max*) seeds at the "Han vegetable wholesale" in Naypyidaw (2018MY01). A girl in one of the shops said that the soybean was from Myingyan, Mandalay. Seeds of 2018MY01 were very small and flat (Seed photo MY01), which were different from those of soybean varieties of Japan and America. It is used for "Pe Pote" or fermented soybeans and "Pe Potte Pya," which is made from "Pe Pote"

to make dried sheets (Photo 30). It was often served on the dinner table during this survey.

We were kindly provided some common beans (*Phaseolus vulgaris* L., 2018MY11) and peas (*Pisum sativum* L., 2018MY12) in Loi Mwae village at an altitude of 1,668 m in Kengtong. Both crops are suitable for cultivation at low temperatures, and the village is considered to be unsuitable for cultivating *Vigna* crops owing to its high altitude or cool climate. In this village, cultivation of broccoli and radish suitable for low temperatures was also popular.

Future perspectives

In this survey, we found an unidentified wild *Vigna* species. Its habitat was a high-altitude limestone plateau area (around 1,500 m) in Taunggyi; hence, this plant might be tolerant to low temperature, alkaline soil, and/or drought condition. This plant could be used as a breeding material for rice bean, because they are morphologically very similar to each other. We plan to conduct morphological characterization, DNA analysis, cross-compatibility test, and stress tolerance evaluation of this plant in order to propose its taxonomic treatment and clarify its useful traits. In addition, *Vigna hirtella* species complex has taxonomic confusion as discussed above. It is occasionally difficult to distinguish plants of *V. angularis*, *V. hirtella* species complex, and *V. tenuicaulis* based on morphological observations. We are attempting to propose a new taxonomic treatment for the section Angulares.

After the seeds collected in this survey from Tsukuba, Japan, are multiplied, we plan to conserve them at the NARO Genebank as a distributable germplasm for education, breeding, and research for food and agriculture (https://www.gene.affrc.go.jp/index_en.php).

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ミャンマーのシャン州における
マメ科遺伝資源の生息域外保全 2018 年

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和文摘要

本報告はミャンマーのシャン州におけるマメ科遺伝資源の保全に関する報告書である．我々は 2018 年 11 月 11 日から 11 月 23 日にかけて，マメ科遺伝資源の収集を目的にシャン州の農村と人為攪乱環境を探索した．なお, この遺伝資源収集は, 日本の農研機構ジーンバンクとミャンマーの農業研究局シードバンクの MOU に基づいて実施された．その結果，ダイズ 1 点，インゲンマメ 1 点，エンドウマメ 1 点，ササゲ 1 点，ジュウロクササゲ 1 点に加えて，作物近縁野生種として野生アズキ 4 点, *Vigna hirtella*（山地型）7 点, *V. minima* 4 点, *V. tenuicaulis* 5 点, *V. umbellata* 2 点, 未同定 *Vigna* 属野生種 4 点，計 31 点が収集された．これらは新種候補となる石灰岩地帯に生息するササゲ属種未同定植物を含む．収集された各種子の半分はミャンマーの農業研究局シードバンクで保存され，残りの半分は SMTA を用いて日本の農研機構ジーンバンクに移転された．農研機構ジーンバンクは，本調査で収集した種子を用いて増殖・特性評価を行った後，食糧農業に関する教育・研究・育種利用目的のために配布可能な遺伝資源として公開予定である（https://www.gene.affrc.go.jp/index_en.php）．

Table 3. Passport data

ID	JP No.	Coll. Date	Scientiic name	Status	Source	Coll. Site	Latitude	Longitude	Altitude (m)	Topography	Soil type	Remarks
MY01	267812	2018/11/12	*Glycine max*	Domesticated	Market	Han vegetable whole sale, Naypyidaw	-	-	-	-	-	seeds came from Myingyan, called "Pae Poke", 1cup = Ks280 = US$0.177
MY02	267813	2018/11/13	*Vigna unguiculata*	Domesticated	Farmer's field	Ote Kyin, Thar Si Township, Mandalay Division	20.815653	96.381714	304	Mountains	Clay	local name "Pae Na Daw (December beans)", cultivar group Unguuiculata
MY03	267814	2018/11/13	*Vigna unguiculata*	Domesticated	Farmer's field	Ote Kyin, Thar Si Township, Mandalay Division	20.815653	96.381714	304	Mountains	Clay	local name "Tai Htaung Pae (Climbing beans)", cultivar group Sesquipedalis
MY04	267815	2018/11/13	*Vigna hirtella* mountain type	Wild	Habitat	Wet Hpyu Yae, Shan State (South)	20.693863	96.503516	616	Mountains	Clay	on a corner of a mountain road
MY05	267816	2018/11/14	*Vigna* sp.	Wild	Habitat	Hpar Mun, Shan State (South)	20.745022	97.0459	1,552	Mountains	Gravel	beside a ditch
MY06	267817	2018/11/14	*Vigna hirtella* mountain type	Wild	Habitat	Baw Kone, Shan State (South)	20.818308	97.366441	1,355	Mountains	Clay	on a terrace upland field near a famous tourist cave
MY07	267818	2018/11/14	*Vigna tenuicaulis*	Wild	Habitat	Loilen, Shan State (South)	20.913719	97.58694	1,334	Mountains	Clay	local name "Pha Kala Mom", a monk told us about its sleep improvement effects of tea produced from *V. tenuicaulis* seeds
MY08	267819	2018/11/14	*Vigna tenuicaulis*	Wild	Habitat	Loi Ye, Shan State (South)	20.944471	97.607609	1,104	Mountains	Clay	near the 180 milestone marker on the road from Kengtong
MY09	267820	2018/11/14	*Vigna hirtella* mountain type	Wild	Habitat	Loi Ye, Shan State (South)	20.944471	97.607609	1,104	Mountains	Clay	one pod collected near the 180 milestone marker on the road from Kengtong
MY10	267821	2018/11/15	*Vigna hirtella* mountain type	Wild	Habitat	Wan Tar Hket, Paing Khing mile 30, Mongping, Shan State (East)	21.342354	98.927133	1,295	Mountains	Sand	opposite side of lunch shop, growing on house garden and around a small water tank
MY11	267822	2018/11/16	*Phaseolus vulgaris*	Domesticated	Farmer's field	Loi Mway, Ken Tong, Shan State (East)	21.177723	99.75938	1,668	Mountains	Organic soil	local name "Neteo", a village chief told us that this bean has some resistance against certain insects and diseases
MY12	267823	2018/11/16	*Pisum sativum*	Domesticated	Farmer's field	Loi Mway, Ken Tong, Shan State (East)	21.177723	99.75938	1,668	Mountains	Organic soil	local name "Wante"
MY13	267824	2018/11/16	*Vigna minima*	Wild	Habitat	Yang Hka, Shan State (East)	20.993537	99.839093	749	Mountains	Clay	growing on a slope with exposed rock along a mountain road
MY14	267825	2018/11/16	*Vigna hirtella* mountain type	Wild	Habitat	Mong Hpyat, Shan State (East)	20.889840	99.864760	541	Mountains	Clay	immature population, no seeds collected, a large population in a stream with stagnating water
MY15	267826	2018/11/16	*Vigna minima*	Wild	Habitat	Mong Hpyat, Shan State (East)	20.889840	99.864760	541	Mountains	Clay	one pod collected on a dry slope
MY15.5	267827	2018/11/17	*Vigna tenuicaulis*	Wild	Habitat	Monghpyak、Shan State (East)	20.886207	99.934006	484	Plain	Clay	growing on an embankment between paddy field
MY16	267828	2018/11/17	*Vigna minima*	Wild	Habitat	Nam Nang, Shan State (East)	20.965748	100.051969	646	Mountains	Clay	growing on a corner of a mountain road
MY17	267829	2018/11/17	*Vigna hirtella* mountain type	Wild	Habitat	Nam Nang, Shan State (East)	20.96597	100.052058	647	Mountains	Clay	growing in bamboo grove on a corner of a mountain road
MY18	267830	2018/11/17	*Vigna minima*	Wild	Habitat	Nam Nang, Shan State (East)	20.96597	100.052058	647	Mountains	Clay	growing in bamboo grove on a corner of a mountain road
MY19	267831	2018/11/17	cf. *Vigna angularis*	Wild	Habitat	Nam Nang, Shan State (East)	20.986032	100.085094	859	Mountains	Clay	growing on a sunny roadside along mountain road
MY20	267832	2018/11/18	*Vigna tenuicaulis*	Wild	Habitat	Pang Nawng Long (Thit), beside Taunggyi-Tarcheileik Rd., Shan State (East)	21.372844	99.217742	924	Mountains	Sand	growing on an embankment between a road and a stream
MY21	267833	2018/11/18	*Vigna umbellata*	Wild	Habitat	Kunhing, Shan State (South)	21.303506	98.441047	504	Mountains	Sand	growing near a lakeside restaurant
MY22	267834	2018/11/19	*Vigna* sp.	Wild	Habitat	Hpar Mun, Taunggyi, Shan State (South)	20.745981	97.044417	1,560	Mountains	Gravel	growing on exposed limestone rock next to a house
MY23	267835	2018/11/19	*Vigna* sp.	Wild	Habitat	Hpar Mun, Taunggyi, Shan State (South)	20.745022	97.0459	1,552	Mountains	Gravel	growing on roadside between a house and a crossroad
MY24	267836	2018/11/19	*Vigna angularis*	Wild	Habitat	Taunggyi, Shan State (South)	20.770437	97.059565	1,652	Mountains	Organic soil	growing on a roadside beside open forest on the way to "Shwe Phone Pwint Pagoda"
MY25	267837	2018/11/19	*Vigna hirtella* mountain type	Wild	Habitat	Taunggyi, Shan State (South)	20.776592	97.050366	1,701	Mountains	Organic soil	no seeds collected on a roadside near "Shwe Phone Pwint Pagoda"
MY26	267838	2018/11/19	*Vigna* sp.	Wild	Habitat	Hpar Mun, Taunggyi, Shan State (South)	20.744395	97.043526	1,577	Mountains	Gravel	no seeds collected on rocky vacant land

Table 3. (Continued).

ID	JP No.	Coll. Date	Scientiic name	Status	Source	Coll. Site	Latitude	Longitude	Altitude (m)	Topography	Soil type	Remarks
MY27	267839	2018/11/19	*Vigna* sp.	Wild	Habitat	Hpar Mun, Taunggyi, Shan State (South)	20.743814	97.043088	1,582	Mountains	Gravel	growing on a roadside
MY28	267840	2018/11/20	*Vigna angularis*	Wild	Habitat	Taung Lar, Kalaw, Shan State (South)	20.602228	96.563055	1,341	Mountains	Clay	growing between a paddy field and a stream
MY29	267841	2018/11/20	*Vigna tenuicaulis*	Wild	Habitat	Taung Lar, Kalaw, Shan State (South)	20.596899	96.564957	1,338	Mountains	Clay	growing along a railway track The collected seeds mixed with *Vigna angularis*.
MY30	267842	2018/11/20	*Vigna hirtella* mountain type	Wild	Habitat	Taung Lar, Kalaw, Shan State (South)	20.596899	96.564957	1,338	Mountains	Clay	growing along a railway track
MY31	267843	2018/11/20	*Vigna angularis*	Wild	Habitat	Taung Lar, Kalaw, Shan State (South)	20.596899	96.564957	1,338	Mountains	Clay	growing along a railway track The collected seeds mixed with *Vigna tenuicaulis*.
MY32	267844	2018/11/20	*Vigna umbellata*	Intermediate	Habitat	Wet Hpyu Yae, Shan State (South)	20.700767	96.516164	953	Mountains	Gravel	growing on a corner of a mountain road
MY33	267845	2018/11/20	*Vigna hirtella* mountain type	Wild	Habitat	Wet Hpyu Yae, Shan State (South)	20.700767	96.516164	953	Mountains	Gravel	growing on a corner of a mountain road

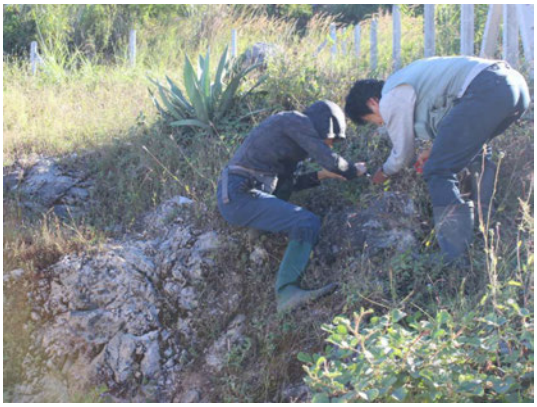


Photo 1. Habitat of 2018MY22, *Vigna* sp. in Taunggyi.

Photo 2. Plant of 2018MY22, *Vigna* sp. in Taunggyi.

Photo 3. Specimen of 2018MY27, *Vigna* sp. in Taunggyi.

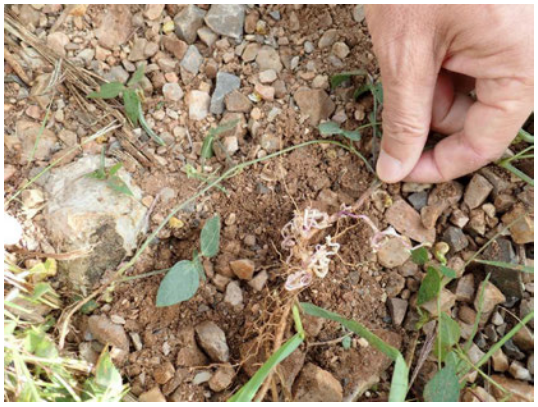


Photo 4. Inflorescence attached to the underground stem of 2018MY23, *Vigna sp*. in Taunggyi.

Photo 5. Pods attached to the main stem at ground surface of 2018MY23, *Vigna* sp. in Taunggyi.

Photo 6. Plant of 2018MY24, wild *Vigna angularis* in Taunggyi.

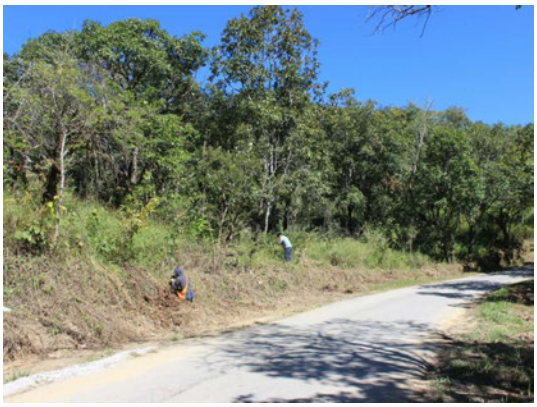


Photo 7. Habitat of 2018MY24, wild *Vigna angularis* in Taunggyi.

Photo 8. Inflorescence of 2018MY24, wild *Vigna angularis* in Taunggyi.

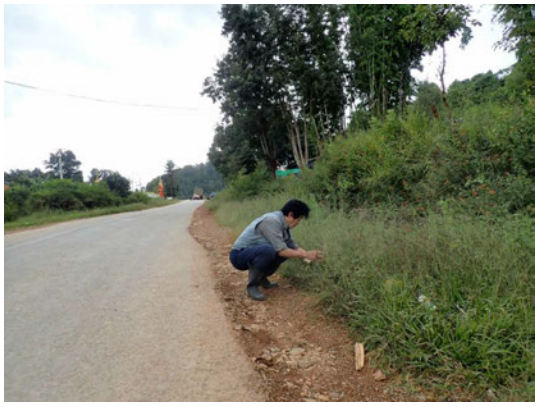


Photo 9. Habitat of 2018MY07, *Vigna tenuicaulis* near Loilem.

Photo 10. Plant of 2018MY07, *Vigna tenuicaulis* near Loilem.

Photo 11. Inflorescence of 2018MY07, *Vigna tenuicaulis* near Loilem.

Photo 12. Mr. Su May Thar who told us about the sleep improvement effect of *Vigna tenuicaulis* seeds at the 2018MY07 site.

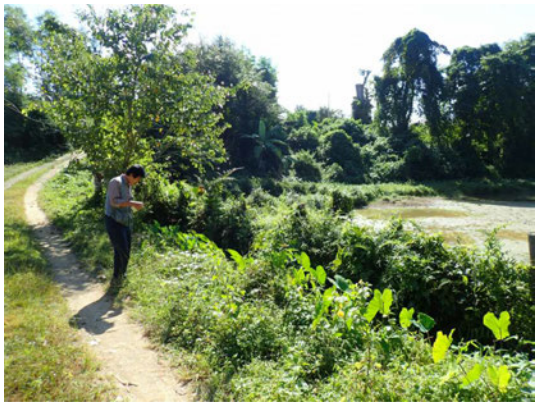


Photo 13. Habitat of 2018MY21, wild *Vigna umbellata* near Kunhing.

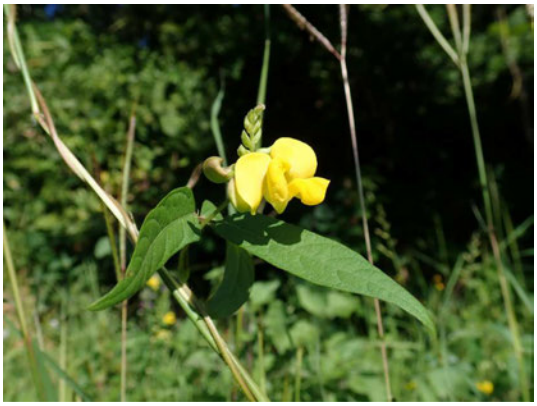


Photo 14. Inflorescence of 2018MY21, wild *Vigna umbellata* near Kunhing.

Photo 15. Stipule of 2018MY21, wild *Vigna umbellata* near Kunhing.

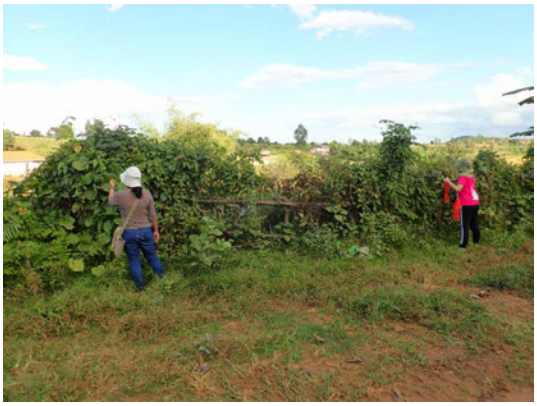


Photo 16. Habitat of 2018MY09, *Vigna hirtella* and 2018MY08, *Vigna tenuicaulis* near Loilem.

Photo 17. Inflorescence of 2018MY09, *Vigna hirtella* mountain type near Loilem.

Photo 18. Inflorescence of 2018MY08, *Vigna tenuicaulis* near Loilem.

Photo 19. Pods of 2018MY09, *Vigna hirtella* mountain type near Loilem.

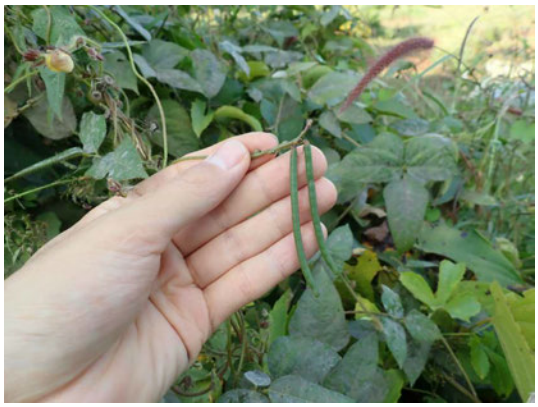


Photo 20. Pods of 2018MY08, *Vigna tenuicaulis* near Loilem.

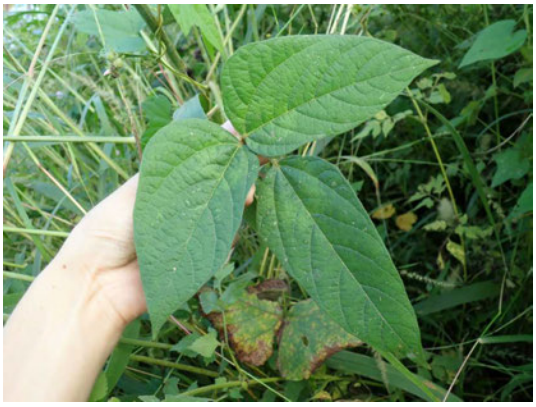


Photo 21. Leaf of 2018MY09, *Vigna hirtella* mountain type near Loilem.

Photo 22. Leaf of 2018MY08, *Vigna tenuicaulis* near Loilem.

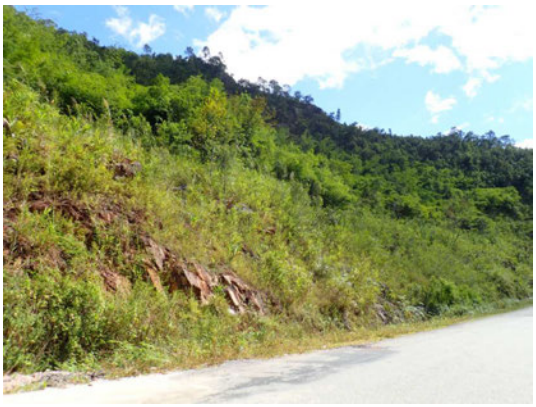


Photo 23. Habitat of 2018MY13, *Vigna minima* near Mong Hpayak.

Photo 24. Stipule of 2018MY13, *Vigna minima* near Mong Hpayak.

Photo 25. The side view of flower on 2018MY13, *Vigna minima* near Mong Hpayak.

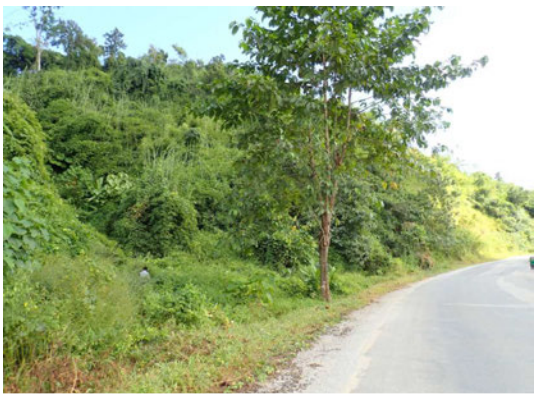


Photo 26. Habitat of 2018MY15, *Vigna minima* and 2018MY14, *Vigna hirtella* mountain type in Mong Hpayak.

Photo 27. Habitat of 2018MY18, *Vigna minima* and 2018MY17, *Vigna hirtella* mountain type near Mong Hpayak.

Photo 28. Pods from 2018MY02, cowpea in Ote Kyin, Thar Si Township, Mandalay Region.

Photo 29. Pods of 2018MY03, yardlong bean in Ote Kyin, Thar Si Township, Mandalay Region.

Photo 30. “Pe Potte Pya” sold at a shop in Loi Mwae, Kengtung.

Seed photos

2018MY01_JP267812_*Glycine max*

2018MY02_JP267813_*Vigna unguiculata* (cowpea)

2018MY03_JP267814_*Vigna unguiculata* (yardlong bean)

2018MY04_JP267815_*Vigna hirtella* mountain type

2018MY05_JP267816_*Vigna* sp.

2018MY06_JP267817_*Vigna hirtella* mountain type

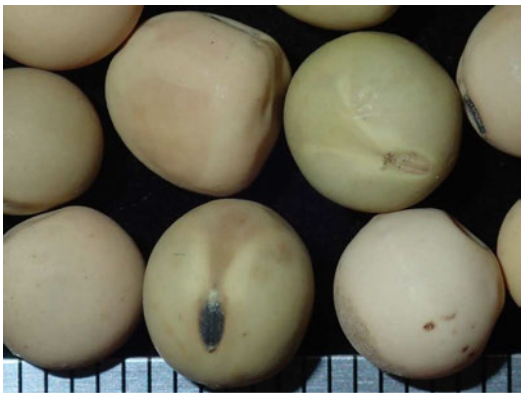
2018MY07_JP267818_*Vigna tenuicaulis*

2018MY08_JP267819_*Vigna tenuicaulis*

2018MY09_JP267820_*Vigna hirtella*
mountain type

2018MY10_JP267821_*Vigna hirtella*
mountain type

2018MY11_JP267822_*Phaseolus vulgaris*



2018MY12_JP267823_*Pisum sativum*

2018MY13_JP267824_*Vigna minima*

2018MY15_JP267826_*Vigna minima*

2018MY15.5_JP267827_*Vigna tenuicaulis*

2018MY16_JP267828_*Vigna minima*

2018MY17_JP267829_*Vigna hirtella* mountain type

2018MY18_JP267830_*Vigna minima*

2018MY19_JP267831_cf. *Vigna angularis*

2018MY20_JP267832_*Vigna tenuicaulis*

2018MY21_JP267833_*Vigna umbellata*

2018MY22_JP267834_*Vigna* sp.

2018MY23_JP267835_*Vigna* sp.

2018MY24_JP267836_*Vigna angularis*

2018MY27_JP267839_*Vigna* sp.

2018MY28_JP267840_*Vigna angularis*

2018MY29_JP267841_*Vigna tenuicaulis* and *Vigna angularis* mixed

2018MY30_JP267842_*Vigna hirtella* mountain type

2018MY31_JP267843_*Vigna angularis* and *Vigna tenuicaulis* mixed

2018MY32_JP267844_*Vigna umbellata*

2018MY33_JP267845_*Vigna hirtella* mountain type