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| メタデータ | <p>言語: eng</p> <p>出版者:</p> <p>公開日: 2020-03-12</p> <p>キーワード (Ja):</p> <p>キーワード (En): crop wild relatives, genetic resources, legume, Vigna</p> <p>作成者: 高橋, 有, 吉田, 沙樹, Ohm, Mar Saw, 友岡, 憲彦</p> <p>メールアドレス:</p> <p>所属:</p> |
| URL | <p>https://doi.org/10.24514/00003229</p> |

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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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Communicated by K. NAITO (Genetic Resources Center, NARO)

Received Nov. 1, 2019, Accepted Dec. 23, 2019

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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, Sagaing 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 | - |

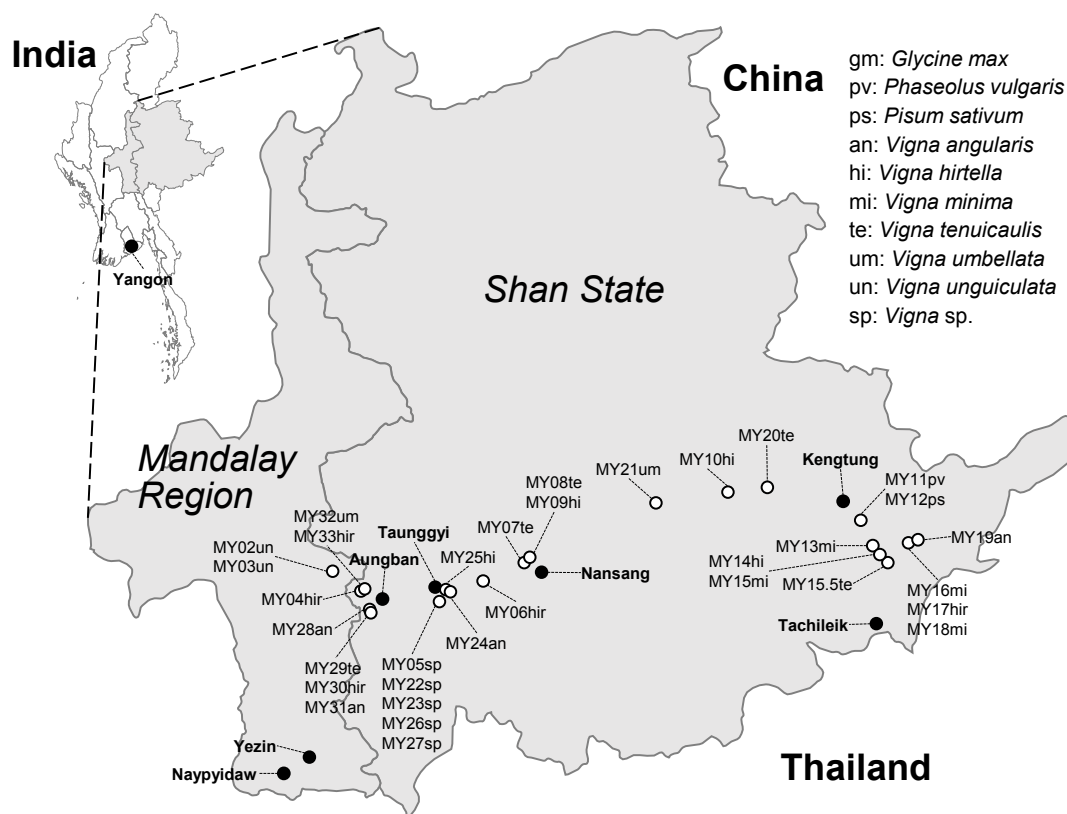


Fig. 1. Map showing the collection sites (white circle) and the major cities (black circle). Two characters after the collection number indicate plant ID abbreviation of the scientific name shown in the upper right legend.

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 | | | |
| <i>Glycine max</i> | - | - | 1 | 1 | - | 1 |
| <i>Phaseolus vulgaris</i> | - | - | 1 | 1 | - | 1 |
| <i>Pisum sativum</i> | - | - | 1 | 1 | - | 1 |
| <i>Vigna angularis</i> | 4 | - | - | 4 | - | 4 |
| <i>Vigna hirtella</i> | 7 | - | - | 7 | 2 | 8 |
| <i>Vigna minima</i> | 4 | - | - | 4 | - | 4 |
| <i>Vigna tenuicaulis</i> | 5 | - | - | 5 | - | 6 |
| <i>Vigna umbellata</i> | 1 | 1 | - | 2 | - | 2 |
| <i>Vigna unguiculata</i> | - | - | 2 | 2 | - | 2 |
| <i>Vigna sp.</i> | 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).

Acknowledgment

This work was supported by the Genebank Project in NARO and a grant from the PGR Asia Project from the Ministry of Agriculture, Forestry and Fisheries of the Government of Japan.

References

- Aitawade MM, Sutar SP, Rao SR, Malik SK, Yadav SR and Bhat KV (2012) Section *Ceratotropis* of subgenus *Ceratotropis* of *Vigna* (Leguminosae-Papilionoideae) in India with a new species from Northern Western Ghats. *Rheedea* 22: 20-27.
- Balan AP, Predeep AV and Udayan AS (2017) *Vigna sathishiana* (Fabaceae): A new species from southern western Ghats, India. *J Jpn Bot* 92: 193-198.
- Castañeda-Álvarez NP, Khoury CK, Achicanoy HA, Bernau V, Dempewolf H, Eastwood RJ, Guarino L, Harker RH, Jarvis A, Maxted N, Müller JV, Ramirez-Villegas J, Sosa CC, Struik PC, Vincent H and Toll J (2016) Global conservation priorities for crop wild relatives. *Nat Plants* 2: 16022.
- Chankaew S, Isemura T, Isobe S, Kaga A, Tomooka N, Somta P, Hirakawa H, Shirasawa K, Vaughan DA and Srinives P (2014) Detection of genome donor species of neglected tetraploid crop *Vigna reflexo-pilosa* (créole bean), and genetic structure of diploid species based on newly developed EST-SSR markers from azuki bean (*Vigna angularis*). *PLoS One* 9: e104990.
- Dixit TM, Sutar SP, Yadav SR, Bhat KV and Rao SR (2011) *Vigna indica*, a new name for *Vigna trilobata* var. *pusilla* and a note on section *Aconitifoliae* in India. *Rheedea* 21: 1-7.
- Domon E, Min San Thein, Takei E, Osada T and Kawase M (2015) A field study collecting cultivated crops and useful plants in Sagaing Region of Myanmar in 2014. *AREIPGR* 31: 343-365

- Gaikwad SP, Gore RD and Randive SD (2015) *Vigna pandeyana* (Fabaceae), a new species from northern western Ghats, India. Biodivers Data J 3: e4606.
- Gaikwad SP, Gore RD, Randive SD and Garad KU (2014) *Vigna yadavii* (Leguminosae: Papilionoideae), a new species from western Ghats, India. Biodiversity Data J 2: e4281.
- Hori Y, Murakoso T, Fukumura M, Torizuka K and Ida Y (2009) Constituents and antioxidative activity of a hot-water extract of adzuki (*Vigna angularis*) beans. J Jpn Soc Nutr Food Sci 62: 3-11 (Japanese with English summary).
- Latha M, Sheen Scariah, Krishnaraj MV, Presannakumari KT, Bhat KV, Bisht IS and Joseph-John K (2014) *Vigna konkanensis* (Fabaceae: Papilionoideae) a new species from the west coast of India. Webbia: Journal of Plant Taxonomy and Geography 69: 49-52.
- Maxted N, Mabuza-Dlamini P, Moss H, Padulosi S, Jarvis A and Guarino L (2004) African *Vigna*: an ecogeographic study. International Plant Genetic Resources Institute, Rome, p. 454.
- Naito K, San San Aye, Min San Thein, Aung Phyoe Hein, Takei E, Osada T, Domon E, Watanabe K and Kawase M (2017) A field study to explore plant genetic resources in the Sagaing Region and Shan State of Myanmar in 2016. AREIPGR 33:2 65-293.
- Ng NQ and Maréchal R (1985) Cowpea taxonomy, origin and germ plasm. In: Singh SR and Rachie KO (eds.). Cowpea Research, Production and Utilization, Wiley, Chichester, pp. 11-21.
- Pasquet RS (1998) Morphological study of cultivated cowpea *Vigna unguiculata* (L.) Walp: Importance of ovule number and definition of cv gr Melanophthalmus. Agronomie 18: 61-70.
- Takahashi Y, Lay-Heng S, Channa T, Makara O and Tomooka N (2015) Exploration of leguminous crops and their wild relatives in western regions of Cambodia, 2014. AREIPGR 31 :121-149.
- Takahashi Y, Peou U, Lay-Heng S, Channa T, Makara O and Tomooka N (2014) Collection and conservation of leguminous crops and their wild relatives in Cambodia, 2013. AREIPGR 30 :109-143.
- Tomooka N, Kaga A, Isemura T and Vaughan DA (2011). Chapter 15, *Vigna*. In: Kole C (ed.). Wild Crop Relatives: Genomic and Breeding Resources Legume Crops and Forages. NY, Springer, pp. 291-311.
- Tomooka N, Kaga A, Isemura T, Vaughan DA, Srinives P, Somta P, Thadavong S, Bounphanousay C, Kanyavong K, Inthapanya P, Pandiyan M, Senthil N, Ramamoorthi N, Jaiwal PK, Jing T, Umezawa K and Yokoyama T (2010) *Vigna* Genetic Resources. In: Proceedings of the 14th NIAS International Workshop on Genetic Resources “Genetics and Comparative Genomics of Legumes (*Glycine* and *Vigna*)”, pp. 11-21.
- Tomooka N, Thadavong S, Inthapanya P, Vaughan DA, Kaga A, Isemura T and Kuroda Y (2006) Conservation of legume - symbiotic rhizobia genetic diversity in Laos, 2005. AREIPGR 22: 149-161.
- Tomooka N, Abe K, Thein MS, Twat W, Ba Maw J, Vaughan DA and Kaga A (2003) Collaborative exploration and collection of cultivated and wild legume species in Myanmar (Oct.15th – Nov. 15th, 2002). AREIPGR 19: 67-83.
- Tomooka N, Vaughan DA, Moss H and Maxted N (2002) The Asian *Vigna*: Genus *Vigna* subgenus *Ceratotropis* genetic resources. Kluwer Academic Publishers, Dordrecht, p. 270.
- Watanabe K, Ye Tint Tun, Kawase M (2007) Field survey and collection of traditionally grown crops in northern areas of Myanmar, 2006. AREIPGR 23: 161-175.

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 | Scientific name | Status | Source | Coll. Site | Latitude | Longitude | Altitude (m) | Topography | Soil type | Remarks |
|--------|--------|------------|-------------------------------------|--------------|----------------|--|-----------|------------|--------------|------------|--------------|--|
| MY01 | 267812 | 2018/11/12 | <i>Glycine max</i> | Domesticated | Market | Han vegetable whole sale, Naypyidaw | - | - | - | - | - | seeds came from Myingyan, called "Pae Poke", 1cup = Ks280 = US\$0.177 |
| MY02 | 267813 | 2018/11/13 | <i>Vigna unguiculata</i> | 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 Unguiculata |
| MY03 | 267814 | 2018/11/13 | <i>Vigna unguiculata</i> | 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 | <i>Vigna hirtella</i> 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 | <i>Vigna</i> sp. | Wild | Habitat | Hpar Mun, Shan State (South) | 20.745022 | 97.0459 | 1,552 | Mountains | Gravel | beside a ditch |
| MY06 | 267817 | 2018/11/14 | <i>Vigna hirtella</i> 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 | <i>Vigna tenuicaulis</i> | 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 <i>V. tenuicaulis</i> seeds |
| MY08 | 267819 | 2018/11/14 | <i>Vigna tenuicaulis</i> | 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 | <i>Vigna hirtella</i> 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 | <i>Vigna hirtella</i> 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 | <i>Phaseolus vulgaris</i> | 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 | <i>Pisum sativum</i> | 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 | <i>Vigna minima</i> | 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 | <i>Vigna hirtella</i> 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 | <i>Vigna minima</i> | 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 | <i>Vigna tenuicaulis</i> | 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 | <i>Vigna minima</i> | 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 | <i>Vigna hirtella</i> 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 | <i>Vigna minima</i> | 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. <i>Vigna angularis</i> | 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 | <i>Vigna tenuicaulis</i> | 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 | <i>Vigna umbellata</i> | Wild | Habitat | Kunhing, Shan State (South) | 21.303506 | 98.441047 | 504 | Mountains | Sand | growing near a lakeside restaurant |
| MY22 | 267834 | 2018/11/19 | <i>Vigna</i> 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 | <i>Vigna</i> 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 | <i>Vigna angularis</i> | 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 | <i>Vigna hirtella</i> 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 | <i>Vigna</i> 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 | Scientific name | Status | Source | Coll. Site | Latitude | Longitude | Altitude (m) | Topography | Soil type | Remarks |
|------|--------|------------|--|--------------|---------|--|-----------|-----------|--------------|------------|-----------|--|
| MY27 | 267839 | 2018/11/19 | <i>Vigna</i> 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 | <i>Vigna angularis</i> | 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 | <i>Vigna tenuicaulis</i> | 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 <i>Vigna angularis</i> . |
| MY30 | 267842 | 2018/11/20 | <i>Vigna hirtella</i> 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 | <i>Vigna angularis</i> | 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 <i>Vigna tenuicaulis</i> . |
| MY32 | 267844 | 2018/11/20 | <i>Vigna umbellata</i> | 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 | <i>Vigna hirtella</i> 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.

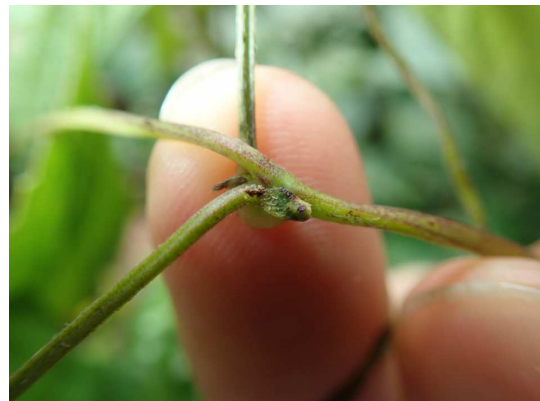


Photo 24. Stipule of 2018MY13, *Vigna minima* near Mong Hpayak.



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



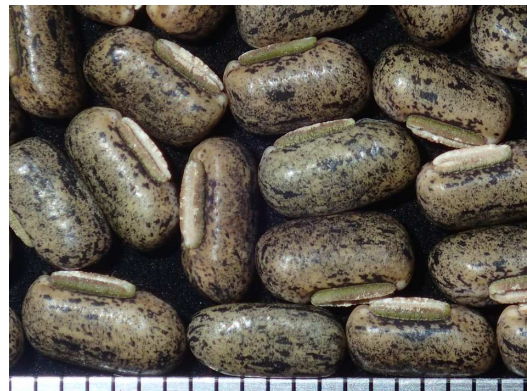
2018MY29_JP267841_Vigna tenuicaulis and
Vigna angularis mixed



2018MY30_JP267842_Vigna hirtella
mountain type



2018MY31_JP267843_Vigna angularis and
Vigna tenuicaulis mixed



2018MY32_JP267844_Vigna umbellata



2018MY33_JP267845_Vigna hirtella
mountain type