
Chiaki MUTO 1), Kohtaro ISEKI 2), Ken NAITO 1)

1) Genetic Resources Center, National Agriculture and Food Research Organization, Kannondai 2-1-2, Tsukuba, Ibaraki 305-8602, Japan
2) Japan International Research Center for Agricultural Sciences, Ohwashi 1-1, Tsukuba, Ibaraki 305-8686, Japan

Communicated by E. DOMON (Genetic Resources Center, NARO)
Received May 15, 2016, Accepted Oct. 25, 2016
Corresponding author: K. NAITO (Email: knaito@affrc.go.jp)

Summary

We surveyed the prefectures of Toyama, Ishikawa, Fukui, Gifu, Aichi, and Mie in Japan for wild relatives of leguminous crops from the 19th to 23rd of October, 2015. From 43 collection sites, we collected 51 accessions, including comprising 30 Vigna angularis var. nipponensis accessions and 21 Glycine soja accessions. We found V. angularis var. nipponensis in the prefectures of Toyama, Ishikawa, Fukui, and Gifu but not Mie and Aichi; and G. soja was found in all six prefectures. We registered all the collected accessions in the NARO Genebank. We will multiply the seeds of the collected accessions and evaluate their growth traits in 2016 at our experimental field in the city of Tsukuba. The multiplied seeds will become available upon request for research, breeding and educational purposes.

KEYWORDS: wild legumes, Vigna, Glycine, genetic resources

Introduction

The NARO Genebank project has been conducting field surveys for the collection and conservation of Vigna and Glycine germplasm distributed throughout Japan (Vaughan et al., 2010; Tomooka et al., 2010; see also Annual Report on Exploration and Introduction of Plant Genetic Resources, https://www.gene.affrc.go.jp/publications.php#plant_report). The genera Vigna and Glycine belong to the legume family (Leguminosae) and include a variety of crops, including azuki bean (Vigna angularis (Willd.) Ohwi & H.Ohashi, Japanese name: azuki), and soybean (Glycine max (L.) Merr., Japanese name: daizu).

We have recently focused on collecting wild and naturally growing accessions of these species because such accessions are likely adapted to the environmental conditions of their corresponding habitats and, thus, may possess tolerance to corresponding biotic and abiotic stresses (McCouch et al., 2013). Wild
azuki bean (*V. angularis* var. *nipponensis* (Ohwi) Ohwi & H.Ohashi) and wild soybean (*G. soja* Siebold & Zucc.) are regarded as the wild ancestors of azuki bean and soybean, respectively. In Japanese language, wild azuki bean is called as yabutsuruazuki, and wild soybean is called as tsurumame.

In the present survey, we explored central region of the main island of Japanese because only a few accessions had been previously collected from this region. We surveyed the prefectures of Toyama, Ishikawa, Fukui, Gifu, Mie, and Aichi from 19th to 23rd October, 2015.

**Methods**

Table 1 shows the schedule of this field survey. On the first of the survey, we started in the city of Toyama, drove east to Nakashinkawa county, turned west, and drove through the city of Himi to the city of Nanao. On the second day, we drove around Noto Peninsula, from the city of Tamasu to Wajima City. On the third day, we started in Kanazawa City and drove down to the city of Echizen. On the fourth and fifth days, we surveyed the Nobi plain in the prefectures of Gifu, Mie, and Aichi (Fig. 1).

Prior to the field survey, we had selected survey sites using Google Earth. The selected sites were located on riverbanks, edges of canals, and borders between paddy fields and shrines or dwellings. For the collection sites, we recorded the corresponding addresses, altitudes, latitudes, longitudes; sketched the surrounding habitat; and noted other ecological information as passport data. The GPS data was measured using handheld GPS device (GPSMAP 62SC; Garmin), and when *V. angularis* var. *nipponensis* or *G. soja* population were located, we collected bulked seed samples.

**Results and Discussion**

We found either of *V. angularis* var. *nipponensis* or *G. soja* at 36 of the 43 survey site (Table 2, Fig. 1) and neither at seven sites, of which six and one were located in the prefectures of Gifu and Mie, respectively. We collected 30 accessions of *V. angularis* var. *nipponensis*, mostly from the prefectures of Toyama, Ishikawa, and Fukui, and 21 accessions of *G. soja*, which was found in all six of the surveyed prefectures (Table 3). The passport data are summarized in Table 4. Photos of the collection sites and collected seeds are shown in Photos 1-55 and Seed Photos 1-51, respectively. We found both *V. angularis* var. *nipponensis* and *G. soja* at six sites, (Toyama 2, Noto 5, Ishikawa 5, Fukui 3, Fukui 4, and Gifu 6), and the two species formed sympatric populations at Toyama 2, Ishikawa 5, and Gifu 6 but not at Noto 5, Fukui 3, and Fukui 4.

**Table 1. Itinerary of the field exploration in Hokuriku and Tokai (Toyama, Ishikawa, Shiga, Gifu, Aichi, and Mie)**

<table>
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<th>Date</th>
<th>Itinerary</th>
<th>Stay</th>
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<tbody>
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<td>2015/10/19</td>
<td>NARO (Ibaraki) → (railway) → Toyama (Toyama) → (Rent a Car) → Yao → Nakashinkawa → Himi → Nanao (Ishikawa)</td>
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<td>Gifu (Gifu)</td>
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<td>2015/10/23</td>
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The collected accessions will be evaluated for their growth traits and be multiplied in 2016 at our experimental field in Tsukuba City. The multiplied seeds will become available upon request for research, breeding, and educational purposes.

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*Vigna angularis* var. *nipponensis*

*Glycine soja*

× No sample

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Fig. 1. A map of collection sites. The numbers in parentheses indicate numbers of collected samples.

The collected accessions will be evaluated for their growth traits and be multiplied in 2016 at our experimental field in Tsukuba City. The multiplied seeds will become available upon request for research, breeding, and educational purposes.
We collected 30 accessions of *V. angularis* var. *nipponensis*. In Ishikawa 4, we found one population, but the seeds were immature and, thus, not collected. Of the 30 accessions, we suspected that 10 represented weedy forms (i.e., forms intermediate between domesticated and wild forms; Table 4). Of these 10 accessions, Noto 6-2, Ishikawa 1-2, Ishikawa 3-1, Ishikawa 4-2, Ishikawa 4-3, and Ishikawa 5-2 exhibited light brown seed coats, a phenotype that is typical of weedy forms (Seed photos 17, 20, 22, 24, 25, and 27; Tomooka et al., 2011). We also suspected that Noto 3-1 (Seed photo 12), Noto 6-3 (Seed photo 18), and Ishikawa 3-2 (Seed photo 23) were weedy because they exhibited intermediate phenotypes in regards to seed size, branching, twining, and pod shattering. Accession Ishikawa 4-1 also exhibited weedy phenotypes; however, seeds were not collected. We also noted that the accession obtained from Gifu 11 lived at the bottom of a shallow stream (Photo 47), which was the wettest habitat encountered during this survey.

Since *V. angularis* var. *nipponensis* often lives along the edges of paddy fields, fallows, canals, and riverbanks, we surveyed such locations and easily identified populations in the prefectures of Toyama, Ishikawa, and Fukui. In these areas we found accessions at 18 of 22 survey sites. An example of a population found in a fallow was the population identified at Toyama 1, where we found a 10 m x 10 m population (Photos 1-3) that was growing in wet soil with grasses. In addition, the *V. angularis* var. *nipponensis* plants at this site were associated with *Persicaria longiseta* (Creeping smartweed, inutade) and *Youngia japonica* (Oriental false hawksbeard, onitabirako). Meanwhile, a typical canal-edge population was identified at Ishikawa 1, where we found a 3 m x 100 m population growing in a riverbank (Photos 20 and 21). In this survey site the plants of *V. angularis* var. *nipponensis* were associated with *Miscanthus sinensis* Andersson (Japanese silver grass, susuki) and *Equisetum arvense* L. (Field Horsetail, sugina). Fukui 3 was a typical riverbank habitat. At this survey site, we found a 10 m x 10 m population growing along the bank of Hino River (Photo 33 and 34), and the plants were associated with *Solidago canadensis* var. *scabra* L. (Canada goldenrod, seitaka awadachisou). Therefore, we concluded that *V. angularis* var. *nipponensis* thrived in these three prefectures (Toyama, Ishikawa, and Fukui).

In the prefectures of Gifu, Mie, and Aichi, however, it was difficult to locate populations, and we were only able to identify *V. angularis* var. *nipponensis* at three of the 14 survey sites, all of which were...
located in Gifu prefecture.

Before this survey, we had conserved few *V. angularis* var. *nipponensis* accessions from the prefectures of Toyama, Ishikawa, Fukui, Mie, or Aichi in NARO Genebank. The present survey allowed us to obtain accessions from Toyama, Ishikawa, Fukui, and Gifu, but not Mie or Aichi. Therefore, we should resurvey the prefectures of Mie and Aichi, probably in areas with higher altitude, such as mountain villages, which are also thought to serve as habitats for the species (Tomooka et al., 2015).

**Glycine soja**

Compared to other regions in Japan, the central region of the main island of Japan is poorly represented in regards to *G. soja* in NARO Genebank. During the present survey, we collected and added accessions from six prefectures. The habitat of *G. soja* is similar to *V. angularis* var. *nipponensis*. However, *V. angularis* var. *nipponensis* was typically found beside streams or canals, whereas *G. soja* was also found in drier habitat, such as Noto 2-1 (Photo 12), which *G. soja* was found growing near an unpaved parking lot. The distribution of *G. soja* also seemed to differ among the prefectures, and the trend was opposite that observed for *V. angularis* var. *nipponensis*. For example, In Toyama prefecture, we only identified a single *G. soja* accession, and in the prefectures of Mie and Aichi, we identified *G. soja* at six of the seven survey site.

**References**


富山県，石川県，福井県，岐阜県，愛知県，三重県におけるマメ科植物遺伝資源の探索収集，2015年

武藤 千秋 1）・井関 洸太朗 2）・内藤 健 1）

1）農研機構・遺伝資源センター
2）国際農林水産業研究センター

和文摘要
本報告は2015年10月19日から23日にかけて実施した富山・石川・福井・岐阜・愛知および三重の6県におけるマメ科作物近縁野生種の探索についての報告である。本調査において43箇所の収集地点を探索し，30系統のヤブツルアズキ（V. angularis var. nipponensis）と21系統のツルマメ（G. soja）を収集した。ツルマメは6県全てで収集できたのに対し、ヤブツルアズキの大部分は富山・石川・福井の3県で収集され、岐阜では3点のみ，三重・愛知での探索地点においては全く発見できなかった。これら収集系統は全て農研機構遺伝資源センター（つくば市）にて栽培し，特性評価および種子増殖を行う予定である。増殖した種子は配布可能な遺伝資源として農研機構ジーンバンクで保存する。
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<th>Degree of disturbance</th>
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Photo 1. Toyama1
Habitat of *V. angularis* var. *nipponensis*

Photo 2. Toyama1
Population of *V. angularis* var. *nipponensis*

Photo 3. Toyama1
*V. angularis* var. *nipponensis* at maturing stage.

Photo 4. Toyama2
Habitat of *V. angularis* var. *nipponensis*.

Photo 5. Toyama2-1
*V. angularis* var. *nipponensis* at maturing stage.

Photo 6. Toyama2-2
*G. soja* at past maturity stage.

Photo 7. Toyama3
Habitat of *V. angularis* var. *nipponensis*

Photo 8. Toyama4
Habitat of *V. angularis* var. *nipponensis*
Photo 9. Toyama5
Habitat of \textit{V. angularis} var. \textit{nipponensis}.

Photo 10. Noto1
Habitat of \textit{V. angularis} var. \textit{nipponensis}.

Photo 11. Noto1
Population of \textit{V. angularis} var. \textit{nipponensis}.

Photo 12. Noto2-1
Habitat of \textit{G. soja}.

Photo 13. Noto2-2
Habitat of \textit{G. soja}.

Photo 14. Noto3
Habitat of \textit{V. angularis} var. \textit{nipponensis}.

Photo 15. Noto4
Habitat of \textit{G. soja}.

Photo 16. Noto5-1
Habitat of \textit{V. angularis} var. \textit{nipponensis}.
Photo 17. Noto5-2
Habitat of *G. soja*.

Photo 18. Noto5
A neighboring field of *V. angularis var. angularis*.

Photo 19. Noto6
Habitat of *V. angularis var. nipponensis*.

Photo 20. Ishikawa1-1
Habitat of *V. angularis var. nipponensis*.

Photo 21. Ishikawa1-2
Habitat of *V. angularis var. nipponensis*.

Photo 22. Ishikawa2
Habitat of *V. angularis var. nipponensis*.

Photo 23. Ishikawa3-1
Habitat of *V. angularis var. nipponensis*.

Photo 24. Ishikawa3-2
Habitat of *V. angularis var. nipponensis*. 
Photo 25. Ishikawa4-1
Habitat of *V. angularis* var. *nipponensis*.

Photo 26. Ishikawa4-2
Habitat of *V. angularis* var. *nipponensis*.

Photo 27. Ishikawa4-3
Habitat of *V. angularis* var. *nipponensis*.

Photo 28. Ishikawa5-1
Habitat of *V. angularis* var. *nipponensis* and *G. soja*.

Photo 29. Ishikawa5-3
Habitat of *V. angularis* var. *nipponensis*.

Photo 30. Fukui1
Habitat of *G. soja*.

Photo 31. Fukui2-1
Habitat of *V. angularis* var. *nipponensis*.

Photo 32. Fukui2-2
Habitat of *V. angularis* var. *nipponensis*. 

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Photo 33. Fukui3-1
Habitat of *V. angularis* var. *nipponensis*.

Photo 34. Fukui3-2
Habitat of *G. soja*.

Photo 35. Fukui4-1
Habitat of *V. angularis* var. *nipponensis*.

Photo 36. Fukui4-2
Habitat of *G. soja*.

Photo 37. Fukui5
Habitat of *V. angularis* var. *nipponensis*.

Photo 38. Gifu2
Population of *Amphicarpaea edgeworthii* var *japonica*.

Photo 39. Gifu2
Flowering and maturing stage of *Amphicarpaea edgeworthii* var *japonica*.

Photo 40. Gifu4
Habitat of *G. soja*.
Photo 41. Gifu6-1
Habitat of G. soja.

Photo 42. Gifu6-2
Habitat of V. angularis var. nipponensis.

Photo 43. Gifu7
Habitat of G. soja.

Photo 44. Gifu8
Habitat of G. soja.

Photo 45. Gifu9
Habitat of G. soja.

Photo 46. Gifu10
Habitat of V. angularis var. nipponensis.

Photo 47. Gifu11
Habitat of V. angularis var. nipponensis.

Photo 48. Gifu14
Habitat of G. soja.
Photo 49. Aichi1
Habitat of *G. soja*.

Photo 50. Aichi2
Habitat of *G. soja*.

Photo 51. Aichi3
Habitat of *G. soja*.

Photo 52. Aichi4
Habitat of *G. soja*.

Photo 53. Aichi5
Habitat of *G. soja*.

Photo 54. Mie1
Habitat of *G. soja*.

Photo 55. Mie1
Habitat of *G. soja*.
Seed Photo 1. Toyama1-1 (JP254555)  
*V. angularis* var. *nipponensis*

Seed Photo 2. Toyama2-1 (JP254556)  
*G. soja*

Seed Photo 3. Toyama2-2 (JP254557)  
*V. angularis* var. *nipponensis*

Seed Photo 4. Toyama3-1 (JP254558)  
*V. angularis* var. *nipponensis*

Seed Photo 5. Toyama4-1 (JP254559)  
*V. angularis* var. *nipponensis*

Seed Photo 6. Toyama4-2 (JP254560)  
*V. angularis* var. *nipponensis*

Seed Photo 7. Toyama5-1 (JP254561)  
*V. angularis* var. *nipponensis*

Seed Photo 8. Noto1-1 (JP254562)  
*V. angularis* var. *nipponensis*
Seed Photo 17. Noto6-2 (JP254571)  
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 18. Noto6-3(JP254572)  
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 19. Ishikawa1-1 (JP254573)  
*V. angularis* var. *nipponensis*

Seed Photo 20. Ishikawa1-2 (JP254574)  
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 21. Ishikawa2-1 (JP254575)  
*V. angularis* var. *nipponensis*

Seed Photo 22. Ishikawa3-1 (JP254576)  
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 23. Ishikawa3-2 (JP254577)  
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 24. Ishikawa4-2 (JP254578)  
*V. angularis* var. *nipponensis* (weedy)
Seed Photo 25. Ishikawa4-3 (JP254579)
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 26. Ishikawa5-1 (JP254580)
*G. soja*

Seed Photo 27. Ishikawa5-2 (JP254581)
*V. angularis* var. *nipponensis* (weedy)

Seed Photo 28. Ishikawa5-3 (JP254582)
*V. angularis* var. *nipponensis*

Seed Photo 29. Fukui1-1 (JP254583)
*G. soja*

Seed Photo 30. Fukui2-1 (JP254584)
*V. angularis* var. *nipponensis*

Seed Photo 31. Fukui2-2 (JP254585)
*V. angularis* var. *nipponensis*

Seed Photo 32. Fukui3-1 (JP254586)
*V. angularis* var. *nipponensis*