

Collection of Wild Relatives of Adzuki Bean, *Vigna riukiensis* and *V. reflexo-pilosa* on Yonaguni Island, Okinawa Prefecture

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Abstract

The usefulness of wild relatives of crop plants for breeding programs is widely recognized. Wild relatives of adzuki bean (*Vigna angularis*), however, have never been collected so far and are not available at the national genebank of the National Institute of Agrobiological Resources in Japan. We conducted an exploration on Yonaguni island, Okinawa prefecture for collecting wild relatives of adzuki bean from November 7 to 9 in 1990. During the exploration, we collected 21 accessions of *V. riukiensis*, 10 of *V. reflexo-pilosa*, 3 of *V. unguiculata* and 4 of *V. marina*. Out of these 4 species, *V. riukiensis* and *V. reflexo-pilosa* belong to the subgenus *Ceratotropis*. *V. riukiensis* is cross-compatible with adzuki bean and it is anticipated that it will be useful for the adzuki bean improvement program. *V. riukiensis* occurred frequently in open and sunny areas along roadsides around Yonaguni island. *V. reflexo-pilosa* occurred inside the island rather than on the seacoast.

KEY WORDS : *Ceratotropis*, adzuki bean, *Vigna riukiensis*, *V. reflexo-pilosa*, *V. unguiculata*, *V. marina*, Yonaguni island, geographical distribution, germplasm collection.

Introduction

Adzuki bean, *Vigna angularis* (WILLD.) OHWI & OHASHI, which is one of the most familiar legumes for Japanese people is prepared in various forms as foods in Japan including “anko” (sweet bean paste), “yohkan” (sweet bean jelly), “seki-han” (red rice ; steamed rice with red adzuki bean), etc. Adzuki bean belongs to the subgenus *Ceratotropis* of the genus *Vigna*. This subgenus contains about 16 species (TATEISHI 1991) and forms a morphologically homogeneous group (BAUDOIN and MARECHAL 1988 ; TATEISHI and OHASHI 1990). Four wild species of *Ceratotropis* described below are anticipated to be collected in Japan.

V. angularis var. *nipponensis*, a wild ancestral form of cultivated adzuki bean, occurs in

Japan, Korea, Taiwan, North China and the Himalayas. *V. nakashimae* (OHWI) OHWI & OHASHI is distributed in Korea, North China and the northern part of the Kyushu region in Japan. The distribution of *V. riukiensis* (OHWI) OHWI & OHASHI is restricted to both the Ryukyu Islands and Taiwan. *V. reflexo-pilosa* HAYATA is widely distributed from South China to Thailand, and also occurs in the Ryukyu Islands and Taiwan (TATEISHI 1984 ; OHASHI *et al.* 1988 ; TATEISHI and OHASHI 1990 ; EGAWA *et al.* 1990).

We collected *V. riukiensis* and *V. reflexo-pilosa* on Iriomote island in 1989 (EGAWA *et al.* 1990). Using those species, we analyzed the cross-compatibility of wild *Ceratotropis* species with adzuki bean (SIRIWARDHANE *et al.* 1991). The objective of the present exploration is to add new accessions to the collection of *V. riukiensis* and *V. reflexo-pilosa* and to document their geographical distribution on Yonaguni island.

Method

We explored Yonaguni island, Okinawa prefecture along roadsides for the collection of *V. riukiensis* and *V. reflexo-pilosa* from 7th to 9th of November in 1990. Yonaguni island is located near Taiwan, at about 123° E and about 24° N (Fig. 1). The circumference of the island is about 27 km. The highest mountain on Yonaguni island is Mt. Urabu-dake, whose altitude is about 230 m.

The species of the subgenus *Ceratotropis* exhibit the following morphological characteristics ; yellow flower with a pocket on keel petal, incurved keel petal, style beak, peltate stipule (TATEISHI 1984 ; OHASHI *et al.* 1988 ; TATEISHI and OHASHI 1990). In the areas where we found plants with trifoliolate leaves or yellow flowers, we observed the leaf and flower morphology and identified the species based on the key characters proposed by TATEISHI (1984). Seeds were collected wherever available.

Results

We collected 21 accessions of *V. riukiensis* and 10 of *V. reflexo-pilosa*. The collection sites are shown in Fig. 1. *V. riukiensis* occurred widely at open and sunny areas along roadsides on the seacoast of Yonaguni island. We also found *V. riukiensis* at the edge of pastures. *V. reflexo-pilosa* was found along roadsides in the area between Higawa and Sonai, and between Higawa and Kubura as shown in Fig. 1. We also found a large number of plants of *V. reflexo-pilosa* in paddy fields at the southern foot of Mt. Kubura-dake, located at about 1.5 km east from Kubura to Higawa.

In addition to *V. riukiensis* and *V. reflexo-pilosa*, we collected two *Vigna* species belonging to the subgenus *Vigna* (Fig. 1). Three accessions of cowpea, *V. unguiculata* (L.) WALP., collected in the Sonai area were all black-testa varieties. The seed length and width were almost

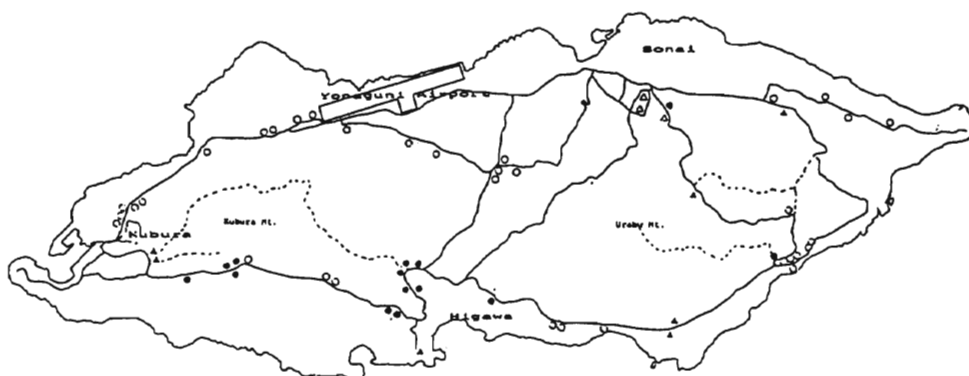


Fig. 1. Distribution of wild *Vigna* species on Yonaguni Island, Okinawa, Japan

- *V. riukiensis* ● *V. reflexo-pilosa*
 △ *V. unguiculata* ▲ *V. marina*

the same as those of the local varieties collected in Ibaraki prefecture. These accessions are considered to be escapes from cultivation and they have acquired a pod shattering habit, which is the natural seed dispersal mechanism. Four accessions of *V. marina* (BURM.) MERR. were collected not only on sandy beaches but also near paddy-fields inside the island.

Discussion

Wild species generally exhibit a wide range of genetic diversity in terms of agronomical characteristics involving pest and disease resistance, rapid growth, environmental adaptation, resistance to lodging, vigorous root system and high-yielding potential (PRESCOTT-ALLEN and PRESCOTT-ALLEN 1988). Wild relatives of cultivated plants are thus essential for crop improvement programs. As for the *Ceratotropis* species, *V. radiata* (L.) WILCZEK var. *sublobata* (ROXB.) VERDC., a wild ancestral form of mungbean, *V. radiata* (L.) WILCZEK., is used as breeding material for resistance to bruchids (FUJII and MIYAZAKI 1987 ; KITAMURA *et al.* 1990 ; TOMOOKA *et al.* 1991), resistance to yellow mosaic virus (SINGH and AHUJA 1977), higher methionine content in seed (BABU *et al.* 1988), higher photosynthetic efficiency and drought tolerance (IGNACIMUTH and BABU 1987) as well as tolerance to salinity, alkaline calcareous soils and cool temperature (LAWN *et al.* 1988). It is anticipated that wild relatives of adzuki bean will also be useful as genetic sources for adzuki bean breeding.

Wild germplasm is now confronted with gradual extinction due to the recent widespread land clearance for the construction of buildings, railways and roads. It is very important that we pay more attention to the collection and preservation of wild relatives of crop plants before they became extinct. Against this background, we started to collect wild relatives of adzuki

bean on the Ryukyu Islands. In 1989 we explored Iriomote island and collected many accessions of *V. riukiensis* and *V. reflexo-pilosa* (EGAWA *et al.* 1990). Moreover, we analyzed the cross-compatibility of these wild species with adzuki bean and rice bean, *V. umbellata* (THUNB.) OHWI & OHASHI (SIRIWARDHANE *et al.* 1991). In 1990 we conducted an exploration on Yonaguni island and we were able to collect many accessions successfully (Fig. 1).

V. riukiensis occurred frequently in sunny areas along roadsides near seashore. We were able to identify many good collection sites for *V. riukiensis* around Yonaguni island and collect 21 accessions. *V. riukiensis* is cross-compatible with both adzuki bean and rice bean when crossed as a pollen parent (SIRIWARDHANE *et al.* 1991). Hybrids between adzuki bean and rice bean are very difficult to produce (RASHID *et al.* 1988). However, *V. riukiensis* can act as a bridge species between adzuki bean and rice bean. Rice bean possesses some valuable characteristics (SAWA and TAN 1976 ; DUKE 1978) and it may be possible to incorporate useful genes from rice bean to adzuki bean through *V. riukiensis*.

V. reflexo-pilosa occurred inside the island rather than on the seacoast (Fig. 1). The plants were twining on grasses or bush, or sometimes trailing in sunny areas near roadsides. *V. reflexo-pilosa* is cross-compatible with *V. glabrescens* MARECHAL, MASSHERPA & STAINER. These two species readily produced fertile hybrids when crossed with each other. Judging from the morphological similarities of seeds and primary leaves, the same ploidy level ($2n = 44, 4x$) and high level of hybrid fertility between them, *V. reflexo-pilosa* was found to be closely related to *V. glabrescens*. Although *V. glabrescens* exhibits pest and disease resistance and is used in the mungbean improvement program at AVRDC in Taiwan (FERNANDEZ and SHANMUGASUNDARAM 1988), only one accession of *V. glabrescens* is now available. In addition to *V. glabrescens*, it is anticipated that *V. reflexo-pilosa* will be useful for the breeding of *Ceratotropis* cultigens.

The subgenus *Ceratotropis* contains five cultigens ; adzuki bean, rice bean, mungbean, blackgram and mothbean. The *Ceratotropis* species from a morphologically homogeneous group (BAUDOIN and MARECHAL 1988 ; TATEISHI and OHASHI 1990) and gene flow occurs within this group through interspecific hybridization (SIRIWARDHANE *et al.* 1991). Wild *Ceratotropis* species should be considered to be primary gene pools for the breeding of the above-mentioned cultigens. However, wild *Ceratotropis* species have never been collected intensively, evaluated and preserved. Considering the genetic erosion occurring rapidly on a world-wide scale, it is important to collect and evaluate wild *Ceratotropis* species from the areas covering their wide range of geographical distribution.

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沖縄県与那国島におけるアズキ近縁野生種, *Vigna riukiensis*, *V. reflexo-pilosa* の探索収集

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緒言

ササゲ属 (*Vigna*) のなかのアズキ亜属 (*Ceratotropis*) は、アジアに起原したと考えられている。この亜属は形態的に同質の約20の種・変種を含む。主要な栽培種は4種からなり、アジアの各国で様々な形で食用にされている。日本には以下に述べる4種の *Ceratotropis* 野生種が自生している。

V. angularis var. *nipponensis* (ヤブツルアズキ) は、栽培アズキの祖先種と考えられるもので、日本(本州~九州)、台湾、中国北部、韓国、ヒマラヤ地帯に分布している。*V. nakashimae* (ヒメツルアズキ) は、韓国、中国北部に分布し、日本では九州北部に自生地がある。*V. riukiensis* (ヒナアズキ) の分布は、八重山諸島と台湾に限定されている。なお、東南アジア大陸部には本種にきわめて近縁な *V. minima* が分布している。*V. reflexo-pilosa* (オオヤブツルアズキ) は東南アジアの大陸部や台湾、八重山諸島に広く分布している。

本探索の目的は、組織的に収集がなされていないアズキ近縁野生種の収集を試み、将来のアズキ品種改良のための遺伝的ベースを広げようとするものである。

収集の方法

周囲約27 kmの与那国島全島を11月7日から9日まで、延べ3日かけて調査した (Fig. 1 参照)。*Ceratotropis* の種は、黄色い花卉、竜骨弁が半回転捻れ、ポケットをもつこと、花柱の先端が嘴状であること、托葉が盾着すること等の形態的特徴を有する。そこで、3小葉で黄色い花を着ける植物を見つけたときに、上述の形態的特徴を観察し、立石 (1984) にしたがって種を同定した。

収集成果

与那国島は、北緯24度、東経123度に位置し、台湾の約30 km 東である。島の周囲は約27 km、最も高い山は宇良部岳で高度約230 m である。

本探索により、Fig. 1 に示した地点で各種の自生場所を見いだした。与那国島の周囲の海岸に近い道路沿いや牧場の周囲の日当りの良い明るい開けた所で *V. riukiensis* が自生し、21点を収集することができた。海岸沿いから島の少し内側に入った道路沿いには、イネ科植物 (ス

スキなど)に巻きついて *V. reflexo-pilosa* が見いだされた。特に比川の集落から祖納, 久部良へ向かう道路沿いで大きな集団を発見した。また, 久部良岳の南側の水田の中でも *V. reflexo-pilosa* を見だし, 合計10点を収集した。アズキの祖先野生種とされるヤブツルアズキは見いだすことができなかった。

Ceratotropis 以外では, *V. marina* (ハマアズキ) と *V. unguiculata* (ササゲ) も収集した。*V. marina* は, 海岸沿いに限らず, 与那国島内部の水田近くでも見だし, 4点収集できた。*V. unguiculata* は, 祖納の集落近くの道路沿いあるいは川沿いで散見し, 3点収集した。これらのササゲは, すべて黒い種皮をもつ品種で, 現在茨城県等で栽培されている品種と種子の大きさは変わらなかった。かつて栽培されていたものからの逸出 (escape) と考えられ, 自然種子散布機構である完全な裂莢性を獲得していた。