

Studies on the Conservation of *Astragalus sikokianus* (Fabaceae) (2): Toward the Sustainable Maintenance of Populations through Natural Regeneration

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Abstract : *Astragalus sikokianus* Nakai, a perennial species of the Fabaceae, was originally described by Dr. Takenoshin Nakai from Naruto City, Tokushima Prefecture, Japan. Although this species was once considered extinct in the wild in Japan, germination of long-preserved seeds has enabled its survival and propagation by local botanists and research institutions. Recently, isolated populations have been confirmed in Korea and northwestern China, suggesting that the present distribution of the species may have been shaped by historical changes in the course of the Yellow River and oceanic currents between the Korean Peninsula and Japan. Based on these findings, this study aimed to promote the sustainable maintenance and natural regeneration of *A. sikokianus* populations through field observations of natural habitats in Korea and outdoor cultivation experiments in Japan. The results revealed that the species exhibits broad ecological adaptability, occurring from coastal to montane regions, and prefers open, well-drained, and sunny habitats. These observations provide essential baseline information for future reintroduction and restoration of wild populations.

Key words : *Astragalus sikokianus*, Fabaceae, habitat, conservation, extinct in the wild

Introduction

Astragalus sikokianus Nakai, a perennial legume species endemic to Naruto City, Tokushima Prefecture, Japan, was first described by Nakai in 1953 (Nakai, 1953; Ohashi, 1982, 2016). The species was initially known only from Naruto City and was regarded as extinct in the wild shortly after its discovery (Akasawa, 1992). Fortunately, seeds collected before extinction were successfully germinated several decades later (Asahi Shimbun, 1973, 1974; Mainichi Shimbun, 1973; Yomiuri Shimbun, 1973; Kinoshita, 2005; Ogawa and Kinoshita, 2017; Tokushima Shimbun, 1973), thereby reviving the species' genetic lineage. Since then, preservation and propagation efforts have been conducted by local enthusiasts and research institutions, including Tokushima University (Imabayashi, 2021), Setsunan University, and the Kochi Prefectural Makino Botanical Garden. However, attempts to reintroduce the species to its original habitat have so far been unsuccessful (Murasawa, 1986; Tokushima Shimbun, 1974).

In the 2000s, new isolated populations of *Astragalus sikokianus* were discovered in Korea and northwestern China (Kim et

al., 2003; Choi et al., 2015, 2016). These findings suggest that the species belongs to a broader East Asian lineage, with its distribution potentially influenced by paleogeographic changes in the Yellow River basin and oceanic currents between the Korean Peninsula and Japan (Kim et al., 2003; Choi et al., 2016). In Japan, a few cultivated populations have achieved fruiting, and under suitable conditions, population maintenance through natural regeneration appears possible (The late Mr. Kenji Wada, pers. comm.).

With this in mind, we initiated a conservation program emphasizing natural germination and establishment under unmanipulated conditions. This paper reports the preliminary results from our 2025 investigations, which include detailed habitat surveys in Korea and field cultivation experiments in Tokushima Prefecture.

1. Habitat in Korea

In July 2025, two of the authors, Ito and Choi, conducted field observations at several natural populations of *Astragalus sikokianus* in Korea to clarify the vegetation composition and environmental characteristics of its habitats. Although Ibaragi et

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Fig. 1. Condition of individuals immediately after transplantation. Individuals A–D are shown from left to right. Individual codes are indicated in the lower left corner of each photograph.

al. (2024) previously reported basic locality information, detailed data on microhabitat, vegetation, and soil moisture conditions were lacking.

Our survey revealed that Korean populations occur both in coastal and montane regions, with altitudes ranging from sea level to about 1,000 m. All sites shared a common substrate of rocky or gravelly soils with thin surface layers and excellent drainage. Individuals were frequently observed in disturbed habitats, such as roadside embankments, cracks beneath guardrails, and concrete gaps near parking areas. Populations along rivers grew in areas occasionally inundated during floods or on exposed rocky beds of dried streams, indicating tolerance to periodic disturbance.

The vegetation surrounding the species resembled that of Japanese open gravel fields, where *Potentilla chinensis* and *Vicia sativa* commonly occur. Plants of *Astragalus sikokianus* exhibited a prostrate growth habit, sprawling over the soil surface. During our survey in July, numerous mature fruits were observed, suggesting that flowering occurred around June.

In montane populations, surrounding vegetation included *Betula platyphylla* and *Sorbus commixta*, indicating a cool and bright environment. Individuals were also found within *Pinus densiflora* forests, demonstrating tolerance to partial shade. In some areas, *Astragalus sikokianus* coexisted with other herbaceous plants but it sometimes became the dominant species depending on seasonal flora change.

Subsequently, one of the authors, Choi, discovered a new and extensive population on Gyodong Island, Ganghwa County, Incheon Metropolitan City. This represents a large, healthy

population of significant conservation value. In contrast, only a few weak individuals were found in southern Korean sites, indicating marked regional variation in habitat quality. Soil samples collected from each site are under analysis, and detailed chemical data will be reported separately.

Overall, *Astragalus sikokianus* in Korea occupies a wider range of habitats than those known from its former Japanese locality around Naruto, where it grew only on coastal gravelly beach. Nevertheless, all populations shared the key characteristic of inhabiting open, sunny, and well-drained environments — a critical factor for its growth and survival.

2. Field Cultivation at Shikoku Alpine Botanical Garden, Gakujin-no-Mori

2-1. Study Site and Methods

Based on the above habitat characteristics, we selected the Shikoku Alpine Botanical Garden, Gakujin-no-Mori in Kamiyama Town, Tokushima Prefecture, as a suitable site for outdoor cultivation and natural regeneration trials. The garden is located at an elevation of approximately 1,000 m and is characterized by a cool climate and abundant spring water. Established in 1972, it has successfully cultivated and preserved many endangered plants such as *Primula sieboldii* var. *sikokiana*, *Anemonopsis macrophylla*, and *Iris gracilipes*.

Transplantation was conducted on April 30, 2025, after the end of local frost (Fig.1). Four seedlings, germinated in February 2023 following the method of Ibaragi (2001) and cultivated in Tokushima City, were used. The four individuals, A to D, were planted under different environmental conditions.



Fig. 2. Condition of individuals in autumn. Individuals A–D are presented from left to right. Individual codes are indicated in the lower left corner of each photograph.

Individual A was planted at a forest margin under partial shade, in humus-rich soil beneath deciduous trees. Individuals B, C, and D were planted near a small wetland within the deciduous forest, where soil moisture remained high and the ground was continuously damp. All sites were enclosed with deer-proof fencing to prevent herbivory.

2-2. Growth Observations

Growth was evaluated six months after transplantation, on October 13, 2025 (Fig.2). Individual A retained two original stems, ca.60 cm long, and showed generally good growth, though with relatively sparse foliage. Individuals B and C, planted in moist forest-edge wetlands, maintained elongated stems, ca.45–60 cm, but exhibited fewer leaves and leaflets. Individual D, which had declined in the wetland, was re-transplanted in July to an open site near the parking area. This plant demonstrated remarkable recovery: although the old stems died back once, new shoots developed vigorously with dense foliage and robust growth. The new site receives full sunlight throughout the day and consists of stony, well-drained soil — conditions might be suggesting the species' preference for bright and aerated environments comparatively. Additionally, no evidence of browsing by deer or rabbits was observed despite the absence of fencing, implying possible chemical or structural deterrence against herbivory.

Our results might be indicating that *Astragalus sikokianus* prefers open, sunlit habitats with moist yet well-drained soils. Both in Korea and Japan, the species grows stably in gravelly or disturbed areas where competition from taller vegetation is

limited.

Previous experiments conducted at the Tokushima Prefectural Museum failed due to complete mortality during the hot and humid summer. The cause remains uncertain but may involve fungal infection or excessive soil moisture. In the present experiment at Shikoku Alpine Botanical Garden, Gakujin-no-Mori, the plants survived the summer and continued to grow, suggesting that this site provides near-optimal conditions for the species at least.

Although no flowering has yet been observed, the vigorous growth of individual D implies a strong potential for future flowering and fruiting. Achieving natural seed production would represent a major step toward establishing a self-sustaining population through natural regeneration.

This study aims to establish a sustainable cultivation system for *Astragalus sikokianus* under natural conditions as a foundation for future reintroduction into the wild. While the present results are preliminary, integrating data from both Korean natural habitats and Japanese cultivation trials has clarified the species' broad environmental tolerance. Continuous monitoring at Shikoku Alpine Botanical Garden, Gakujin-no-Mori will determine whether natural regeneration through flowering and seedling recruitment can occur. Ultimately, we envision this effort as a collaborative model involving local citizens, universities, and museums working together to conserve endangered plant species in Japan.

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References

- Akasawa, Y. 1992. *Don't let the Astragalus sikokianus seed die out*. In: H. Kimura, (ed.), *Awa-no-shizen Tanpo*, p. 143–145. Tokushima City Library, Tokushima. (in Japanese)
- Asahi Shimbun. 1973. *Extinct Astragalus sikokianus: The romance of Mr. Kinoshita, a teacher in Naruto City, succeeded in raising seedlings*. 28 Jun. 1973. (in Japanese)
- Asahi Shimbun. 1974. *Former school principals plan to establish a research group with the aim of reviving extinct plants in Naruto*. 05 Mar. 1974. (in Japanese)
- Choi, I. S., S. Y. Kim and B. H. Choi. 2015. A taxonomic revision of *Astragalus* L. (Fabaceae) in Korea. *Korean Journal of Plant Taxonomy*, 45 (3): 227–238.
- Choi, I. S., D. P. Jin and B. H. Choi. 2016. A Taxonomic study of *Astragalus sikokianus* with a disjunct distribution between northwestern China and the Korea-Japan region. *Journal of Japanese Botany*, 91 (Suppl.): 217–230.
- Ibaragi, Y. 2001. Characteristics of seed germination of *Astragalus sikokianus*. *Bulletin of the Tokushima Prefectural Museum*, (11): 101–104.
- Ibaragi, Y., I. S. Choi, S. Kinoshita, Y. Ito, M. Ogawa and T. Kogame. 2025. Habitat of *Astragalus sikokianus* in Korea (Fabaceae). *Bulletin of the Tokushima Prefectural Museum*, (35): 183–186.
- Imabayashi, K. 2021. Germination test of an extinct wild plant, *Astragalus sikokianus*. The University of Tokushima Technical Support Department Technical Report, 4: 14–15. (in Japanese)
- Kim, S. Y., B. H. Choi and E. S. Jeon. 2003. New distribution of *Astragalus sikokianus* Nakai (Leguminosae) in Korea. *Journal of Japanese botany*, 78 (3): 167–169.
- Kinoshita, S. 2005. Memories with Dr. Yoshiyuki Akasawa. Restoration of *Astragalus sikokianus* and Natural Hybridization of *Artemisia gilvescens*. *Botany in Kochi Prefecture*, (19): 16–22. (in Japanese)
- Mainichi Shimbun. 1973. *Astragalus sikokianus, known as a very rare plant, has flowered*. 16 Aug. 1973. (in Japanese)
- Murasawa, Y. 1986. *Is there any suitable location for Astragalus sikokianus?* *Seibutsu report Tokushima*, (4): 9–10.
- Nakai, T. 1953. *Opera phytologica novissima*. *Bulletin of the National Science Museum, Tokyo*, 33: 1–30.
- Ogawa, M. and S. Kinoshita. 2017. Two rare plants in Naruto City, *Astragalus sikokianus* Nakai and *Artemisia gilvescens* Miq. *Proceedings of Awagakkai*, (61): 185–188. (in Japanese)
- Ohashi, H. 1982. *Astragalus* L. In: Y. Satake et al., (eds.), *Wild Flowers of Japan. Herbaceous Plants (including Dwarf Subshrubs) 2*, p. 190–192. Heibonsha, Tokyo. (in Japanese)
- Ohashi, H. 2016. *Astragalus* L. In: H. Ohashi, Y. Kadota, H. Kihara, J. Murata and K. Yonekura, (eds.), *Wild Flowers of Japan 2*, p. 256–259. Heibonsha, Tokyo. (in Japanese)
- Tokushima Shimbun. 1973. *Revived Phantom Flower*. 07 Aug. 1973. (in Japanese)
- Tokushima Shimbun. 1974. *The Astragalus sikokianus, known as the "Phantom plant," has been planted in Naruto Park*. 01 Jun. 1974. (in Japanese)
- Yomiuri Shimbun. 1973. *Astragalus soakings, known as the phantom plant, germinated again after a 20-year absence*. 27 Jun. 1973. (in Japanese)

摘要

ナルトオウギ *Astragalus sikokianus* Nakai (マメ科) の保全に関する研究 (2)

—自然更新による持続的な個体群維持を目指して—

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マメ科の多年草であるナルトオウギ *Astragalus sikokianus* Nakai は、1953 年に中井猛之進によって徳島県鳴門市産の標本をもとに記載された。本種は一時期、日本国内では野生絶滅したと考えられていたが、長期間保存されていた種子の発芽に成功したことにより、研究機関および地元の植物研究者によって生存・増殖が可能となった。近年では、韓国および中国北西部にも隔離分布する個体群が確認されており、これらの分布は黄河流路の変遷や朝鮮半島と日本の間を流れる海流の影響を受けて形成された可能性が示唆されている。

本研究では、これらの知見を踏まえ、韓国における自生地の現地観察および日本国内での露地栽培実験を通じて、ナルトオウギの個体群を自然更新により持続的に維持することを目的とした。その結果、本種は海岸から山地に至るまで幅広い環境に適応し、開放的で日照が得られ、水はけの良い環境を好むことが明らかとなった。これらの成果は、本種の再導入および野外個体群の再確立に向けた重要な基礎資料となるものである。

