

Exploration and Collection of two Crabapple species, *Malus spontanea* Makino and “Takanabe kaidō,” in Southern Kyūshū, Japan

Hiroyuki IKETANI¹⁾ and Nobuko MASE¹⁾

1) NARO Institute of Fruit Tree Science, 2-1 Fujimoto, Tsukuba 305-8615, Japan.

Summary

We explored the Kirishima Mountains in southern Kyūshū and collected *Malus spontanea* Makino. This is an endemic species whose natural habitat is limited to the Ebino-kōgen high plateau in the Kirishima Mountains. This area has been designated as a National Natural Monument. Although the natural growing habitat is deteriorating and the number of individual trees has decreased by about half, we were still able to discover 296 trees and we were able to collect scions from 11 of them.

In addition, we investigated “Takanabe kaidō”, which is an undescribed plant discovered about 30 year ago. We collected scions from four cultivated trees. A total of 15 genetic resources were collected during this project.

KEY WORDS : fruit tree, crabapple, *Malus*, endangered species, Kirishima, Kyūshū

Introduction

There are four native species of the genus *Malus* (apple) in Japan. Among them, *M. tschonoskii* (Maxim) C.K. Schneid. is very different from the other three and is now classified the genus *Docyniopsis*¹⁾. *M. toringo* (Siebold) Siebold ex de Vriese (syn. *M. sieboldii* Rehder) and *M. baccata* (L) Borkh. var. *mandshurica* (Maxim.) C.K. Schneid., are widely distributed, especially across northern Japan. These two species have already been used in horticulture as rootstock, gene source for disease resistance²⁾, and various other uses. We have also extensively searched for these species in the various regions of Japan^{3), 4), 5), 6), 7)}, as well as undertaking taxonomic studies on them^{8), 9)}.

The last species, *Malus spontanea* (Makino) Makino (Japanese name “Nokaidō”) is very different from the other species in its distribution. It is an endemic species whose natural habitat is limited to the Ebino-kōgen high plateau in the Kirishima Mountains running through Miyazaki Pref. and Kagoshima Pref. Based on morphology this species is most closely related to *M. halliana* Koehne which is distributed throughout the middle of China¹⁰⁾. It is possibly a single species with disjunct distribution.

This tree has attracted attention from the general public as well as the academic

community since its discovery in 1910^{11,12)}. Not long after this in 1923, this area was designated as a National Natural Monument. However, no attempt at conservation was made during the Rapid Economic Growth after World War II or since then even though the Ebino-kōgen has become a major tourist spot on Kyūshū Island. Conservation activity for this plant has only been promoted in the last fifteen years. As a result, the number of trees has been reduced from 504 (in 1967) to 334 (in 1998)¹³⁾. This species is now classified as endangered (IB) in the Red List of Threatened Plants of Japan¹⁴⁾.

The NIAS Genebank already has an accession of this species (JP173406). However it was obtained from a public institute and its true origin is unknown. We therefore our aim was to explore its natural habitat and collect enough accessions to cover its entire genetic diversity. This was completed during this project.

We also made it our aim to collect “Takanabe kaidō” which is an undescribed plant of the Crabapple species discovered about 30 years ago^{15), 16)}. It is now conserved only in cultivation.

Methods

The natural habitat of *Malus spontanea* is protected by different regulations. Therefore, we first of all submitted applications for permission to the District Forestry Offices under Forestry Law, to the Regional Environmental Office under the Natural Parks Law, and to Prefectural Boards of Education under the Cultural Properties Protection Law.

Our first field investigation was carried out from 22nd to 28th April 2012 so as to identify the exact location and present aspect of all trees. The information of the precise location of each tree was provided by Dr. T. Nakao (pers. commun.). The second field investigation was conducted from 3rd to 4th August 2012. At this time we observed the condition of fruiting on trees. Finally we performed the collection of scions from 27th November to 1st December 2012.

The information on “Takanabe kaidō” was provided by Mr. T. Ninamitani, the discoverer of this plant, and Mr. S. Tokitō.

Results and Discussion

1) The present status of the natural population of *Malus spontanea*

The Ebino-kōgen high plateau is situated near the northwest end of the Kirishima Mountains, which is an assemblage of volcanoes (Fig. 1, 2). The plateau is surrounded by volcanoes, such as Mt. Karakuni-dake, Mt. Ebino-dake, and others. Volcanic sediment from these mountains is accumulated in the valley between them thus forming the plateau. This area is now upstream of the Nagae-gawa River whose branches flow westward.

The boundary of its natural habitat extended for about 2-km square (Fig.2, dashed line). However, most of the individual native trees grow along the current or former riverside in about a 500-m square area on the southern part of the plateau (Fig. 2, solid line). Though several trees have been newly discovered especially outside of the plateau, the overall number of trees has decreased from 334 to 296. The trees don't seem to be very vigorous (Photo 1). The various reasons for this weakening have been hypothesized, for example, shading from other trees such as the Japanese Red Pine (*Pinus densiflora*) and foraging damage from Japanese deer (*Cervus nippon*).

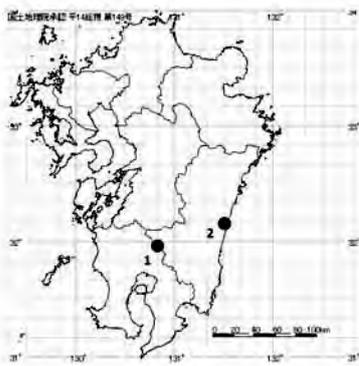


Fig.1. Investigated sites of genetic resources

1: Ebino-kōgen

2: Takanabe Town.

This map was made with KenMap¹⁹⁾

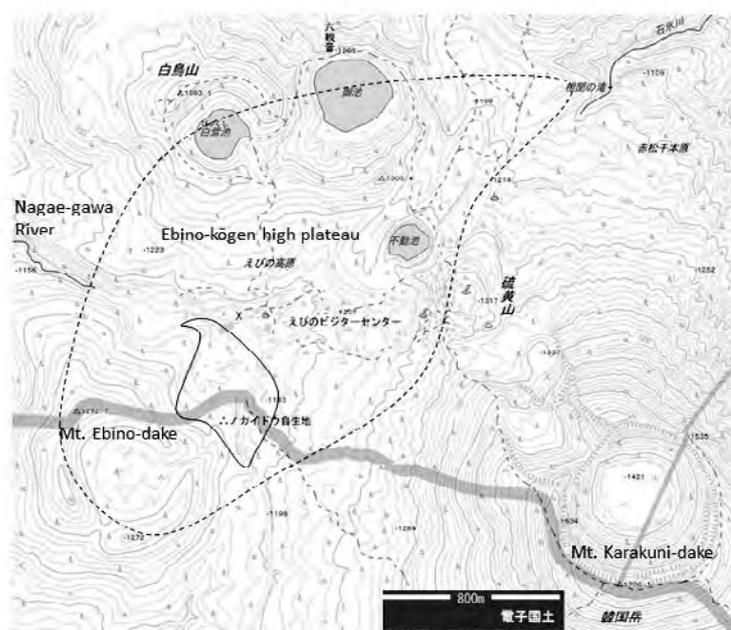


Fig. 2. A detailed map of the Ebino-kōgen high plateau

Dashed line: Boundary of natural habitat of *Malus spontanea*.

Solid line: Principal growing area of *M. spontanea*.

Heavy line: The border between Miyazaki Prefecture (northern part) and Kagoshima Prefecture (southern part)

2) Cultivation of “Takanabe kaidō”

This plant was originally discovered in a marsh near Takanabe Town. It is now no longer found in this area. Several dozen of these trees are now cultivated mainly in Takanabe Town. We investigated several trees planted in public spaces as well as private gardens.

3) Collection of *Malus spontanea* and “Takanabe kaidō”

Taking into consideration the vigorousness of these trees and the ease of collection, we collected scions from 11 trees of the *M. spontanea* (Table 1). For the “Takanabe kaidō” we collected scions from four trees (Table 1).

4) Future prospects

From the 19th to the beginning of the 20th century, many plants that originated in Japan were exported to Western countries and used in agriculture, horticulture and for other purposes. The same is true in the case of the *Malus*. The most used Japanese species is perhaps *M. floribunda* Siebold. Not only is it one of the most famous ornamental crabapples¹⁷⁾, but also germplasm belonging to this species has become a valued gene source for disease resistance¹⁸⁾. However, the true geographical origin of this species is still unclear. Makino hypothesized, about 100 year ago^{11), 12)}, that *M. spontanea* might be the botanical origin of *M. floribunda*, however, this hypothesis is still unproven. There is also uncertainty in many cases about the botanical and geographical origins of existing conserved genetic resources of *Malus* which are thought to have originated in Japan. We think it is important to deduce these origins so as to aid in the exploitation of new and useful genetic resources from natural populations. We are

going to address this problem using the germplasms that we collected from this and previous explorations.

Acknowledgements

We would like to gratefully and sincerely thank Dr. T. Nakao, Professor of the Miyazaki University, for providing consultation throughout the project as well as for providing us with his unpublished data. We would also like to thank Mr. T. Minamitani for providing consultation from the beginning of the project as well as providing us with the information on “Takanabe kaidō”. We would also like to thank Mr. S. Tokitō for guiding us in the cultivation of “Takanabe kaidō”. We are also grateful to the Ebino Office of Rangers for Nature Conservation, Ministry of Environment, to the Kagoshima District Forestry Office and the Miyakonojō Suboffice of the Miyazaki District Forestry Office, Forestry Agency, Ministry of Agriculture, Forestry and Fisheries, and to the Miyazaki Prefectural Boards of Education and the Kagoshima Prefectural Boards of Education, for permission to investigate and collect plant materials.

References

- 1) Lo E.Y.Y. Lo and M.J. Donoghue (2012) Expanded phylogenetic and dating analyses of the apples and their relatives (Pyreae, Rosaceae). *Molecular Phylogenetics and Evolution* 63: 230-243.
- 2) Moriya S., H. Iwanami, S. Takahashi, N. Kotoda, K. Suzaki, T. Yamamoto and K. Abe (2010) Genetic mapping of the crown gall resistance gene of the wild apple *Malus sieboldii*. *Tree Genetics & Genomes* 6: 195-203.
- 3) Iketani H., N. Mase and Y. Sato (2006) Exploration and collection of *Pyrus* and *Malus* genetic resources in Northern Tohoku region. *Annual Report on Exploration and Introduction of Plant Genetic Resources* 22: 13-21 (in Japanese).
- 4) Iketani H., N. Mase and Y. Sato (2007) Exploration and collection of *Pyrus* and *Malus* genetic resources in Nagano and Yamanashi Prefectures. *Annual Report on Exploration and Introduction of Plant Genetic Resources* 23: 55-61.
- 5) Iketani H., N. Mase and Y. Sato (2008) Exploration and collection of rosaceous fruit tree genetic resources in Toyama and Ishikawa Prefectures. *Annual Report on Exploration and Introduction of Plant Genetic Resources* 24: 55-61.
- 6) Iketani H. and N. Mase (2009) Exploration and Collection of *Malus* and *Pyrus* genetics resources in Tochigi Prefecture. *Annual Report on Exploration and Introduction of Plant Genetic Resources* 25: 61-69.
- 7) Iketani H., K.E. Hummer, J.D. Postman, H. Imanishi and N. Mase (2010) Collaborative Exploration between NIAS and USDA/ARS (U.S. Department of Agriculture, Agricultural Research Service) for the Collection of Genetic Resources of Fruit and Nut Species in Hokkaidō and the Northern Tōhoku Region. *Annual Report on Exploration and Introduction of Plant Genetic Resources* 26: 13-26.
- 8) Iketani H. and H. Ohashi (2001) *Malus*. In: Iwatsuki K. et al., (eds.) *Flora of Japan* Iib. Angiospermae Dicotyledoneae Archichlamydeae (b): 120-123. Kodansha, Tokyo.
- 9) Iketani H. (2004) Rediscovery of *Malus baccata* var. *mandshurica* at Nikko and the

- reexamination of its taxonomy. *Bunrui* 4: 125-136 (in Japanese).
- 10) Rehder A. (1940) *Malus*. in: *Manual of Cultivated Trees and Shrubs Hardy in North America* (2nd. ed.): p.389-399. Macmillan, New York.
 - 11) Makino T. (1910) “Kaidō no Genshu to Mitomubeki Yaseihin”. *Bot. Mag.*, Tokyo 24: 66-67 (in Japanese).
 - 12) Makino T. (1914) Observations on the flora of Japan. *Bot. Mag.*, Tokyo 28: 288-295.
 - 13) Nakao T. and Y. Tsuruzoe (1998) “Tennen kinenbutsu Nokaidō no Genkyōchōsa to Hogo zōshoku Hōkokusho” no Gaiyō. *Kokuritsu Kōen No.569*: 22-26 (in Japanese).
 - 14) Ministry of Environment of the Government of Japan (2012) The Fourth Red List of Threatened plants of Japan. http://www.biodic.go.jp/rdb/rl2012/RL2012siryo7_1.pdf
 - 15) Minamitani T. (1985) “Miyazaki-ken Takanabe-daichi no Shokubutsu”. *Shokubutstu to Shizen* 19: 28-31 (in Japanese).
 - 16) Minamitani T. (2005) New taxa discovered from southern Kyushu and those preservation. *Bunrui* 5: 67-84 (in Japanese).
 - 17) Fiala J.L. (1994) *Flowering Crabapples*. 273pp., Timber Press, Portland.
 - 18) Way R.D., H.S. Aldwinckle, R.C. Lamb, A. Rejman, S. Sansavini, T. Shen, R. Watkins, M.N. Westwood and Y. Yoshida (1991) Apples (*Malus*). In: Moore J.N., et al. (eds.) *Genetic Resources of Temperate Fruit and Nut Crops* 1: 3-62. International Society for Horticultural Science, Wageningen.
 - 19) Kamada, T. (2009) KenMap ver. 8.32. <http://www5b.biglobe.ne.jp/~t-kamada/CBuilder/kenmap.htm>.

和文摘要

宮崎県鹿児島県にまたがる霧島山系のえびの高原において、この箇所を唯一の自生地とするリンゴ属の固有種であり、国指定天然記念物であるノカイドウ (*Malus spontanea* (Makino) Makino) の探索調査を行った。自生地の生育環境は悪化しつつあり、自生個体数もこの約 50 年間で半減近くになっているが、296 株を確認し 11 個体から穂木を収集した。

また、同県高鍋町で約 30 年前に前に発見され、分類学的所属が不明であるタカナベカイドウ (*Malus* sp.) の探索調査も行い、栽培個体 4 株から穂木を収集した。以上合わせて 15 点の遺伝資源の収集を行った。

Table 1. List of *Malus spontanea* and “Takanabe kaidō” investigated in this exploration

Species	Locality	Longitude	Latitude	Designation ^{a)}	JP number	Note ^{b)}
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'46"	31°56'20"	COL/MIYAZAKI/2012/NIAS/001	247376	No. 6
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'45"	31°56'23"	COL/MIYAZAKI/2012/NIAS/002	247377	No. 11
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'41"	31°56'23"	COL/MIYAZAKI/2012/NIAS/003	247378	No. 32
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'38"	31°56'22"	COL/MIYAZAKI/2012/NIAS/004	247379	No. 43
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'36"	31°56'22"	COL/MIYAZAKI/2012/NIAS/005	247380	No. 45
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'36"	31°56'21"	COL/MIYAZAKI/2012/NIAS/006	247381	No.111
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'36"	31°56'21"	COL/MIYAZAKI/2012/NIAS/007	247382	No.112
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'36"	31°56'32"	COL/MIYAZAKI/2012/NIAS/008	247383	No.195
<i>Malus spontanea</i>	Ebino-kōgen, Ebino City, Miyazaki Pref.	130°50'36"	31°56'32"	COL/MIYAZAKI/2012/NIAS/009	247384	No.197
<i>Malus spontanea</i>	Ebino-kōgen, Kirishima City, Kagoshima Pref.	130°50'28"	31°56'30"	COL/KAGOSHIMA/2012/NIAS/001	247385	No.265
<i>Malus spontanea</i>	Ebino-kōgen, Kirishima City, Kagoshima Pref.	130°50'27"	31°56'30"	COL/KAGOSHIMA/2012/NIAS/002	247386	No.267
"Takanabe kaidō" (<i>Malus</i> sp.)	Cultivated at the Takanabe Museum of Art, Takanabe Town, Miyazaki Pref.	131°30'15"	32°07'15"	COL/MIYAZAKI/2012/NIAS/010	247387	
"Takanabe kaidō" (<i>Malus</i> sp.)	Cultivated at the Takanabe Museum of Art, Takanabe Town, Miyazaki Pref.	131°30'15"	32°07'15"	COL/MIYAZAKI/2012/NIAS/011	247388	
"Takanabe kaidō" (<i>Malus</i> sp.)	Cultivated at the Takanabe Museum of Art, Takanabe Town, Miyazaki Pref.	131°30'15"	32°07'15"	COL/MIYAZAKI/2012/NIAS/012	247389	
"Takanabe kaidō" (<i>Malus</i> sp.)	Cultivated at Kurodani Park, Takanabe Town, Miyazaki Pref.	131°30'17"	32°07'40"	COL/MIYAZAKI/2012/NIAS/013	247390	

a) Designation using in the NIAS Genebank

b) Number of label attached to each tree for identifying individual of *M. spontanea*



Photo 1. Natural growing habitat of *Malus spontanea* in the Ebino-kōgen high plateau (3 Aug. 2012)



Photo 2. Infructescences of *M. spontanea* (28 Nov. 2012)



Photo 3. Cultivated trees of “Takanabe kaidō” at the Takanabe Museum of Art, Takanabe Town (1 Dec. 2012)



Photo 4. Infructescences of “Takanabe kaidō” (1 Dec. 2012)