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Alien plants collected or confirmed on the islands of Shikotan, Kunashir and Iturup on the 2009–2012 Botanical Expeditions

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Abstract
Alien plants collected or confirmed by photographs during the 2009-2012 botanical expeditions to the islands of Shikotan, Kunashir and Iturup were reported. In all, 21 alien plants were newly found from these islands: Aegopodium podagraria L., Daucus carota L. subsp. carota, a double-flowered form of Achillea ptaurica L., Rudbeckia laciniata L. var. hortensis L.H.Bailey, Solidago gigantea Aiton subsp. serotina (Kuntze) McNeill, Tanacetum vulgare L. var. vulgare, Echium vulgare L., Symphytum ×uplandicum Nyman, Brassica napus L., Cakile edentula (Bigelow) Hook., Saponaria officinalis L., Chenopodium ficifolium Sm., Lupinus polyphyllus Lindl. Melilotus officinalis (L.) Pall. subsp. suaveolens (Ledeb.) H.Ohashi, Trifolium campestre Schreb., Hypericum perforatum L. Mentha ×gracilis Sole, Oxalis dillenii Jacq., Anthoxanthum odoratum L. subsp. glabrescens (Čelák.) Asch. et Graebn., Elytrigia repens (L.) Desv. ex B.D.Jackson var. aristata (Doell) Prokud. and Lolium perenne L. All the alien plants reported to date, including those we found, were analyzed in an invasive period and with a geographical relationship. Some details were determined for the especially harmful invasive species found during our expedition: Rudbeckia laciniata L., Solidago gigantea Aiton, Cakile edentula (Bigelow) Hook., and Aegopodium podagraria L.

Key words: alien, Cakile edentula, Iturup, Kunashir, Kuril Islands, Rudbeckia laciniata, Shikotan,

Introduction
Some alien species are harmful to native species, and the mechanism behind their interaction has been discussed from many angles (e.g. Gurevitch and Padilla, 2004; Travestet and Richardson, 2006). Didham et al. (2005) suggested that ultimate causes of population decline by invasive plants are species specific and context dependent. Pyšek et al. (2004) noted that checklists of alien plant species with reliable information of identification and status are indispensable to consider the problem of alien plants. Such a checklist will necessary in understanding regional flora, as well as to support and promote ecological research, which will help to consider the conservation problems of the locality.

Many studies have been carried out on alien plants in Japan (Osada 1972, 1976, Tachikake 1998, Shimizu, N. et al. 2001, Shimizu, T. 2003, Uemura et al. 2010). A manual and list of the alien plants have also been published in Hokkaido (Igarashi 2001, Hokkaido 2010). However, comparatively few studies have been carried out on the alien species of the Kuril Islands.

The presence of alien plants on these islands has already been noted by Tatewaki (1957), Barkalov (2009) and others. However, many of these works aimed to clarify the entire flora of the islands, and information on alien plants, its status and their distribution ranges are described fragmentally. In order to understand the ecological status of the islands, it is necessary to identify alien species, their characteristics, the period of invasion, and their present status in the regional flora.

During 2009 — 2012, we went on expeditions to the Shikotan (2010), Kunashir (2009, 2012) and Iturup (2012) Islands of the southern Kuril Islands on the theme “joint research on the invasive species and rare & endangered species of the southern Kuril Islands”. During the study, we had the chance to study the ecological condition of the islands, including the situation of alien species. We considered the period of these species’ introduction according to the literature and compared floristic similarity to neighboring territories. On the basis of our results, we gave special attention to some invasive species that might have harmful effects to the native vegetation of these islands.
Materials and Methods

We investigated alien plants at several places on Shikotan in 2010, Kunashir in 2009, 2013, and Iturup in 2013. The places investigated included natural meadows and forests, and vacant or disturbed places around and within the settlements of these islands.

A list of alien plants collected and confirmed in these islands is presented in this paper. Family and species names generally follow Murata and Yonekura (2012) and are ordered alphabetically. In the entries, the species name, [Japanese name], and (the risk categories of the menace of the naturalized plant in Hokkaido) are noted. The risk categories follow the scheme of Hokkaido (2010).

The naturalized age in the southern Kurils (Shikotan, Kunashir and Iturup) was estimated from the records of Miyabe (1860), Tatewaki (1957), and Barkalov (2009) and our data. The introduced age is classified into the following periods; 1) the Ainu period, in which naturalized plants were first recorded in Miyabe (1860), 2) the Japanese period, in which the plants in question were first recorded in Tatewaki (1957), 3) the Russian period, in which the plants were first recorded in Barkalov (2012), and 4) the Newest period, in which the plants in question were first recorded in the present study, including our recent records (Fukuda et al. 2013). The floristic similarity of the alien plants was clarified in comparison with plants in the neighboring territories: Hokkaido (Igarashi 2001) and Sakhalin (Smirnov 2002). The localities for each species were arranged from southwest to northeast. The specimens and photographs listed are deposited in SAPS (Herbarium, the Hokkaido University Museum, Sapporo). Annotations have been added for some species. Terms follow Pyšek et al. (2004).

Results and Discussion

1. List of alien plants of the three islands

Alien species, collected or confirmed by photographs in field research 2009-2012 from Shikotan, Kunashir and Iturup are described. During the research, the following 21 alien plants were first found in the southern Kurils: Aegopodium podagraria L., Daucus carota L. subsp. carota, a double-flowered form of Achillea ptarmica L., Rudbeckia laciniata L. var. hortensis L.H.Bailey, Solidago gigantea Aiton subsp. serotina (Kuntze) McNeill, Tanacetum vulgare L. var. vulgare, Echium vulgar L., Symphytum ×uplandicum Newn, Brassica napus L., Cakile edentula (Bigelow) Hook., Saponaria officinalis L., Chenopodium ficifolium Sm., Lupinus polyphyllus Lindl., Melilotus officinalis (L.) Pall. subsp. suaveolens (Ledeb.) H.Ohashi, Trifolium campestre Schrebr., Hypericum perforatum L., Mentha ×gracilis Sole, Oxalis dillenii Jacq., Anthoxanthum odoratum L. subsp. glabrescens (Čelák.) Asch. et Graebn., Elytrigia repens (L.) Desv. ex B.D.Jackson var. aristata (Doell) Prokud. and Lolium perenne L.

APIACEAE

Aegopodium podagraria L. [Iwa-mitsuba] (Hokkaido: A2) Newest period!


Note: Cultivated plants were left growing in the central part of Yuzhno-Kuril’sk, Kunashir. On Hokkaido this species was introduced and planted in a garden, but after that, it escaped and is now invading forests. Due to its strong propagation by long branching rhizomes, Hokkaido (2010) regarded this species as a high-risk invasive plant on Hokkaido (A2 rank).

Daucus carota L. subsp. carota [Nora-ninjin] (Hokkaido: A3) Newest period!


Note: This species was found at the side of the main road within Kuril’sk. It was not common there.

ASTERACEAE

Achillea millefolium L. [Seiyō-nokogiri-sō] (Hokkaido: A3) Russian period.


Achillea ptarmica L., double-flowered cultivar. [Obana-nokogiri-sō] (Hokkaido: B) Newest period!


Note: This species was found at the side of the main road within Kuril’sk. It may have escaped or been left growing in a garden.


Note: A double-flowered form of this species was found in a waste area. It may have escaped or been left growing in a garden.

Arctium lappa [Takahashi & T. Fukuda 35633.]

Arctium tomentosum Mill. [Watage-gobō] (Hokkaido: —) Russian period.


Bellis perennis L. [Hinagiku] (Hokkaido: B) Russian period.

Centaurea jacea L. [Yaguruma-azami] (Hokkaido: B) Russian period.


Erigeron annuus (L.) Pers. [Himejoon] (Hokkaido: A3) Russian period.

Erigeron strigosus Muhl. ex Willd. [Heraba-himejoon] (Hokkaido: B) Russian period.

Galinsoga parviflora Cav. [Kogome-giku] (Hokkaido: A2) Russian period.


Gnaphalium uliginosum L. [Hime-chichiko-gusa] (Hokkaido: B) Russian period.


Leucanthemum vulgare [Furansu-giku] (Hokkaido: A2) Russian period.

Note: Miyabe (1890) recorded this species from Urup as “ex Max.” which refers the information from Dr. Maximowicz, recorded as Matricaria discoidea DC. in his flora. Thus M. matricarioides is an old naturalized plant that may have been introduced to the Kurils by Russians.

Note: In Sakhalin, this species commonly invades mountain meadows.

Rudbeckia hirta [Arage-hangon-sō] (Hokkaido: B) Russian period.
Note: A population found in Kunashir is considered a horticultural race of this species, and is similar to “Gloriosa Daisy” (Kunashir, Mt. Mechnikova. Aug. 24, 2012. Y. Kato 2012-293).

Note: This species forms thick, dense colonies around the mouth of the Tyatina River (Onnebetsu-gawa) at the southwest foot of Mt. Tyatya. For conservation of the natural meadow vegetation, the plants should be removed.

Rudbeckia laciniata L. var. hortensis L.H.Bailey [Hanagasa-giku] (Hokkaido: A2, included in R. laciniata). Newest period!
Note: Igarashi (2001) listed this variety as a naturalized plant on Hokkaido. This variety is planted in gardens, and has escaped often on Hokkaido.

SHIKOTAN: Aug. 6, 2010. A. Taran s.n.

Solidago gigantea Aiton subsp. serotina (Kuntze) McNeill [Ō-awadachi-sō] (Hokkaido: A2) Newest period!
Note: This species is designated as an A2 naturalized plant on Hokkaido, and removing work has been carried out in several places. However, this plant has not been previously reported from the Kuril Islands (Barkalov 2009), so this is a new record for the Kurils. It forms thick, dense colonies in the suburbs of Kuril’sk, so it should be removed as for Rudbeckia laciniata.

Tanacetum vulgare L. var. vulgare [Yomogi-giku] (Hokkaido: B) Newest period!
Note: This variety was growing in a wasteland within the village of Ryedovo.

Taraxacum officinale [Seiyō-tanpopo] (Hokkaido: A2) Japanese period?
Note: Tatewaki reported 10 species of Taraxacum, including invasive T. laviegatum DC. in the Kuril Islands. Hence, Taraxacum officinale may also have invaded in the Japanese period.

BALSAMINACEAE
Impatiens glandulifera Royle [Oni-tsurihunesō] (Hokkaido: A3) Russian period.

BORAGINACEAE
Ecium vulgare L. [Shibenaga-murasaki] (Hokkaido: B) Newest period!
Note: This species is a comparatively rare alien plant on Hokkaido, and it may have recently escaped from a garden in the town of Yuzhno-Kuril’sk.

Symphytum × uplandicum Nyman [Comfrey] (Hokkaido: A3) Newest period!
Note: This species is regarded as a prehistorically introduced plant in Japan (as *C. holosteoides* var. *hallaisanense* in Shimizu 2003). Miyabe (1890) recorded it as *C. vulgaris* L. var. *glandulosum* Koch. from Iturup, so it may be an old plant naturalized to the Kurils. Barkalov (2009) also regarded it as a plant naturalized to the Kurils.

*Sagina procumbens* L. [*Araito-tsumekusa*] (Hokkaido: B) Russian period.


Note: This species was found in a wasteland in the suburbs of Kuril’sk. It may have recently escaped from cultivation in a garden. This species was not recorded in the Kurils (Barkalov 2009), but was recorded in Sakhalin (Barkalov and Taran 2004).

*Silene vulgaris* (Moench) Garaece [*Shiratama-sō*] (Hokkaido: B) Russian period.


*Spargula arvensis* var. *sativa* (Boenn.) Mert. et W.D.J.Koch [*Ō-tsumekusa*] (Hokkaido: A3) Japanese period.


Note: This species was found in a wasteland in the suburbs of Kunashir. Barkalov (2009) also regarded it as a prehistorically introduced plant in Japan (as *C. vulgatum* L. var. *glandulosum* Koch. from Iturup, so it may be an old plant naturalized to the Kurils. Barkalov (2009) also regarded it as a plant naturalized to the Kurils.

*Spergularia rubra* [Usubeni-tsumekusa] (Hokkaido: B) Russian period.


Note: Plants having white papillose seeds are recognized as var. *arvensis*, which is popular in Hokkaido; on the other hand, plants having the seeds without small white papillae are described as var. *sativa*, which is popular on Sakhalin. Thus, *S. arvensis* var. *sativa* of the southern Kurils shows more similarity to Sakhalin than to Hokkaido in the variety rank.

*Stellaria graminea* L. [Karafuto-hosoba-hakobe] (Hokkaido: B) Russian period.


Note: This species was recorded in Sakhalin (Barkalov and Taran 2004). Miyabe (1890) recorded it as *S. arvensis* var. *sativa*. Note: This species is regarded as a prehistorically introduced plant in Japan (as *C. holosteoides* var. *hallaisanense* in Shimizu 2003). Miyabe (1890) recorded it as *C. vulgaris* L. var. *glandulosum* Koch. from Iturup, so it may be an old plant naturalized to the Kurils. Barkalov (2009) also regarded it as a plant naturalized to the Kurils.

*Stellaria media* [Ko-hakobe] (Hokkaido: B) Ainu period.


Note: This species is regarded as a prehistorically introduced plant in Japan (as *C. holosteoides* var. *hallaisanense* in Shimizu 2003). Miyabe (1890) recorded it as *C. vulgaris* L. var. *glandulosum* Koch. from Iturup, so it may be an old plant naturalized to the Kurils. Barkalov (2009) also regarded it as a plant naturalized to the Kurils.
plant to Japan (Shimizu 2003), and at the end of the 1800s, it was very common at Kuril’sk and elsewhere in Iturup (Miyabe 1890). Barkalov (2009) regarded it as a species naturalized to the Kuril Islands.

**CHENOPODIACEAE**

*Chenopodium album* L. [Shiroza] (Hokkaido: B) Ainu period.

**Note:** This species is regarded as native in Japan (Shimizu 2009), but Igarashi (2001) regarded it as naturalized to Hokkaido. Barkalov (2009) regarded it as naturalized to the Kurils, and Miyabe (1890) had already recorded it from Shikotan and Iturup. Thus, it may be a prehistorically naturalized plant in the Kurils.

*Chenopodium ficifolium* Sm. [Ko-akaza] (Hokkaido: B) Newest period!

**CONVOLVULACEAE**

*Convolvulus arvensis* L. [Seiyō-hirugao] (Hokkaido: A3) Russian period.

*Melilotus officinalis* (L.) Pall. subsp. *suaveolens* (Ledeb.) H.Ohashi [Shinagawa-hagi] (Hokkaido: A3) Newest period!

**Note:** This species was growing sporadically in wastelands within the town of Kuril’sk.

*Trifolium campestre* Schreb. [Kusudama-tsumekusa] Newest period!


**FABACEAE**

*Lupinus polyphyllus* Lindl. [Shukkon-lupinus] (Hokkaido: A3) Newest period!


**GERANIACEAE**

*Geranium sibiricum* L. [Ichige-fūro] (Hokkaido: + ) Japanese period?

**HYPERICACEAE**

*Hypericum perforatum* L. [Seiyō-otogiri] (Hokkaido: B) Newest period!

**JUNCACEAE**

*Juncus bufonius* L. [Hime-kōgai-zekishō] (Hokkaido: - ) Japanese period?

**Note:** This species is recognized as a native plant of Japan (Shimizu 2003) as it is of Hokkaido (Igarashi 2001), but Barkalov (2009) regarded it as a naturalized plant of the Kurils.
Because Miyabe (1890) did not record it but Tatewaki (1957) did from the Kurils, this species must have introduced to the Kurils in the early 1900s.

**Juncus tenuis** Willd. [Kusa-i] (Hokkaido: –) Japanese period?


**LAMINACEAE**

**Elsholtzia ciliata** (Thunb.) Hylander [Naginata-Kōju] (Hokkaido: +) Japanese period?


**Galeopsis bifida** Boenn. [Chishima-odorikosō] (Hokkaido: A3) Japanese period?


**Mentha × gracilis** Sole [America-hakka] (Hokkaido: B) Newest period!


**ONAGRACEAE**


**OROBANCHACEAE**


**PLANTAGINACEAE**

**Plantago lanceolata** L. [Hera-ōbako] (Hokkaido: A2) Russian period.
**POACEAE**

*Agrostis gigantea* [Konuka-gusa] (Hokkaido: A3) Russian period.


**Elytrigia repens** (L.) Desv. ex B.D.Jackson var. *aristata* is distinguished from *E. repens var. repens* in having the long awns. This infraspecific taxon may be included in *E. repens* by Russian botanists, but this variety name has not been reported before in the southern Kurils, so we regarded it as a new alien.

**Elytrigia repens** (L.) Desv. ex B.D.Jackson var. *repens* [Shibamugi] (Hokkaido: A3) Russian period.


**Festuca pratensis** [Hirohano-ushinokegusa] (Hokkaido: A3) Russian period.

KUNASHIR: Cape Chetverikova to mouth of Andreyevka River.

**Avena fatua** L. [Karasu-mugi] (Hokkaido: A3) Japanese period?


**Bromus inermis** Leyss. [Ko-suzumenomachihiki] (Hokkaido: A3) Russian period.


**Avena fatua** L. [Haru-gaya] odoratum (Čelak.) Asch. et Graebn. [Kenashi-harugaya] (Hokkaido: A3) Newest period!


Note: It is regarded as a prehistorically introduced plant in Japan (Shimizu 2003).


**Elytrigia repens** (L.) Desv. ex B.D.Jackson var. *repens* [Shibamugi] (Hokkaido: A3) Russian period.


**Festuca pratensis** [Hirohano-ushinokegusa] (Hokkaido: A3) Russian period.

KUNASHIR: Cape Chetverikova to mouth of Andreyevka River.
**Holcus lanatus** L. [Shirage-gaya] (Hokkaido: B) Russian period.

**Lolium perenne** L. [Hoso-mugi] (Hokkaido: A3) Newest period!

**Phalaris arundinacea** [Kusa-yoshi] (Hokkaido: A3) - Native plant.

**Poa annua** L. [Numa-ichigotsunagi] (Hokkaido: B) - Native plant.

**Poa pratensis** L. [Nagaha-gusa] (Hokkaido: A3) Ainu period.


**Phleum pratense** L. [Ô-awagaeri] (Hokkaido: A3) Ainu period.

**Kusa** s. lat. in Japan is composed of both native plants and naturalized plants introduced after the Meiji period (Shimizu 2003). Igarashi (2001) regarded it as a native species (prehistorically introduced) on Hokkaido. Barkalov (2009) regarded it as the naturalized species of the Kuril Islands, but Miyabe (1860) has already recorded it from the Kurils. This species may include both prehistorically introduced individuals and new aliens in the Kurils.

**Poa pratensis** L. [Naga-hiotsunagi] (Hokkaido: A3) Ainu period.

**Poa annua** L. [Suzumeno-katabira] (Hokkaido: +) Ainu period.

**Note:** It is a very common naturalized plants of the southern Kurils.

**Poa annua** L. [Suzumeno-katabira] (Hokkaido: +) Ainu period.

**Note:** Barkalov (2009) recognized it as a native plant of the Kurils. This plant is listed as a naturalized plant of Japan (Shimizu 2003), but Shimizu (2003) pointed out the possibility of the presence of native individuals on Hokkaido. Here we regard it as a native plant of the Kurils as in the opinion of Barkalov (2009).

**Poa pratensis** L. [Naga-hiotsunagi] (Hokkaido: A3) Ainu period.

**Note:** Barkalov (2009) recognized it as a naturalized plant of the Kurils. Shimizu (2003) noticed the possibility of native plants of *P. pratensis* in the Japanese mountains, and Igarashi (2001) also noticed both the naturalized and native individuals on Hokkaido. Miyabe (1860) has already recorded this species, so at least some plants are native or prehistorically introduced to the Kurils.
**Poa trivialis** L. [Ô-suzumeno-katabira] (Hokkaido: A3) Russian period?


**Schedonorus pratensis** (Huds.) Beauv. [Hiroha-ushinoke-gusa] (Hokkaido: A3) Russian period.


**Persicaria maculosa** Gray [Haru-tade s.l.] (Hokkaido: +) Russian period.


Note: Plants collected from Dobryn Bay and from Sredneye, Iturup, had short inflorescence and low spreading stems, and are considered as *P. maculosa* ssp. *maculosa*. However, this plant had some hairless glands on inflorescences. As our specimens were difficult to identify at the subspecies level, we adopted *P. maculosa* s.l.

**Persicaria nepalensis** (Meisn.) H.Gross [Tani-soba] (Hokkaido: +) Japanese period?


Note: *Polygonum aviculare* L. is regarded as a prehistorically introduced plant of Japan (Shimizu 2003) and Hokkaido (Igarashi 2001). Barkalov (2009) recognized it as a naturalized plant of the Kurils.


Note: Within *R. acetosella* L., two infraspecific taxa, subssp. *acetosella* and subsp. *pyrenaicus*, are recognized (Murata and Yonekura 2012). Barkalov (2009) recognized both *Acetosella angiocarpa* (Murb.) A. Löve and *Acetosella vulgaris* (Koch) Fourr. in the Kurils, but it is difficult to compare the two taxonomic opinions.

**Rumex longifolius** DC. [Nodaiō] (Hokkaido: +) Russian period?


Note: This species is commonly recognized as a native plant of Japan (Shimizu 2003) and Hokkaido (Igarashi 2001). However, Barkalov (2009) regarded it as a naturalized plant of the Kuril Islands. According to our observations, this species is sometimes found in wastelands around residential area in Shikotan and Kunashir. In the present study, we regard it as a naturalized plant of the southern Kurils as in the opinion of Barkalov (2009).
In the Russian period, 154 introduced species were recorded. This means that during the 50 years of this period, the number of introduced species increased was three times higher than in the prehistoric to Japanese period, although this number may include plants that were introduced once but will not become naturalized. The large percentage of Asteraceae and Poaceae are distinctive. Of the 154 species, 38 species (24.7%) are Asteraceae and 27 species (17.5%) are Poaceae. Common alien species of the Kurils that Barkalov (2009) indicated, e.g. *Agrostis gigantea* Roth, *Leucanthemum vulgare* Lam., *Rudbeckia laciniata* L. and *Taraxacum officinale* DC. Thus, *T. officinale* possibly also invaded in the Japanese period.

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In this period, many other alien species were found in this region (e.g. on the continent of Asia). Barkalov (2009) stated that the number of naturalized to the Kurils on the prehistoric to the Japanese period, 154 during Russian period, and 21 new aliens found in our expedition. Another 59 plants, found in this region (e.g. on Hokkaido or Sakhalin), have not been recorded from the Kurils. The results indicated that the number of naturalized to the Kuril Islands is increasing, especially in the recent period.

Many species estimated to have been introduced in the prehistoric to Japanese period are those commonly seen in the natural environment, such as *Plantago major* L., *Poa annua* L., *Persicaria nepalensis* (Meisn.) H.Gross, *Trifolium repens* L., *T. pratense* L. and others. Barkalov (2009) described the naturalized species commonly found on almost all the Kuril Islands: *Phleum pratense* L., *Poa annua* L., *Stellaria media*, *Trifolium repens* L., *T. pratense* L., *Agrostis gigantea* Roth, *Leucanthemum vulgare* Lam., *Rudbeckia laciniata* L. and *Taraxacum officinale* Weber ex F. H. Wigg. Among them, the presence of five species (*Phleum pratense*, *Poa annua*, *Stellaria media*, *Trifolium repens*, *T. pratense*) is attributed to this period. *Taraxacum officinale* is not noted either in Miyabe (1890) or Tatewaki (1957), but Tatewaki listed 10 species of *Taraxacum*, including invasive *T. laviegatum* DC. Thus, *T. officinale* possibly also invaded in the Japanese period.

In the recent period, 154 introduced species were recorded. This means that during the 50 years of this period, the number of introduced species increased was three times higher than in the prehistoric to Japanese period, although this number may include plants that were introduced once but will not become naturalized. The large percentage of Asteraceae and Poaceae are distinctive. Of the 154 species, 38 species (24.7%) are Asteraceae and 27 species (17.5%) are Poaceae. Common alien species of the Kurils that Barkalov (2009) indicated, e.g. *Agrostis gigantea* (Poaceae), *Leucanthemum vulgare* (Asteraceae), and *Rudbeckia laciniata* (Asteraceae), are all included in this period, showing their comparably rapid ratio of dispersal. Many species of this invasive period grow around settlements and fields, as *Plantago lanceolata* L., *Erigeron annuus* (L.) Pers., *Thlaspi arvense* L., *Digitaria ciliaris* (Retz.) Koeler, *Anthoxanthum odoratum* L. and others. Human activity seems to have provided suitable conditions for their growth. Some species of the Poaceae may have been introduced as pasture grass; *Lolium perenne* L., *Echinochloa crus-galli* (L.) P.Beauv. and others belong to this period. On the other hand, we noted many plants that seemed to have escaped from cultivation: *Impatiens glandulifera* Royle, *Symphytum × uplandicum* Nyman, *Rudbeckia hirta*, *R. laciniata* and others.
In the newest period, species categorized as A2–A3 in the Blue list of Hokkaido (Hokkaido, 2010) included Aegopodium podagraria L., Solidago gigantea Aiton subsp. serotina (Kuntze) McNeill and Cakile edentula (Bigelow) Hook. These may harm native plants, as already observed on Hokkaido or Honshu, and their occurrence in the Kurils will need to be monitored for a long period. In addition, we found a high percentage of plants that escaped from cultivation: Rudbeckia laciniata L. ‘Hortensis’, Rudbeckia hirta, Achillea ptarmica (double-petaled form) and others. Melilotus officinalis (L.) Pall. subsp. suaveolens (Ledeb.) H.Ohashi and Trifolium campestre Schreb. were found along asphalt roads, and may have been introduced during infrastructure construction.

3. Phytogeographic comparisons between the southern Kurils, Sakhalin and Japan

Alien plants of 280 species were compared regionally. Among the 280 species, 221 were found in the Kuril Islands. For the southern Kurils, the number of alien plants was highest on Kunashir (174). The number was lower on Iturup (133), Shikotan (83) and the Habomai Islands (40).

Among the 221 alien plants of the Kuril Islands, 124 species (56.1%) were seen both in Hokkaido and on Sakhalin, 49 (22.2%) were found on Hokkaido but not on Sakhalin, and 30 (13.6%) were found on Sakhalin but not on Hokkaido. There were 16 species (7.2%) found only on the Kuril Islands, not in adjacent regions (e.g. H. Okkaido, Sakhalin), and more than 90% of the alien species of the Kuril Islands had species common with adjacent regions.

Comparison of the alien species found on Kunashir and Iturup revealed the tendency for more plants on Kunashir to be common to Hokkaido (138 plants, 83.1%) than those on Sakhalin (126 plants, 72.4%), but on Iturup, more plants were common to Sakhalin (101 plants, 75.9%) than to Hokkaido (89 plants, 66.9%). Both of the islands had plants commonly seen in wastelands or fields, such as Taraxacum officinale, Plantago lanceolata and Gnaphalium uliginosum. The plants observed on Kunashir but not on Iturup included escaped plants from gardens, such as Narcissus pseudonarcissus L., Aster novi-belgii L., Impatiens glandulifera Royle, and Iris pseudacorus L. Among the alien plants found only on Iturup were species widely distributed in northern hemisphere, such as Galeopsis ladanum L., Rhinanthus vernalis (N.W. Zinger) Schischk. & Serg., species of genus Odontites and others.

Interestingly, on Kunashir and Iturup, several species were found that are not seen in adjacent regions, such as Amaranthus blitoides S. Watson, Euclidiyum syriacum (L.) W. T. Aiton and Campanula latifolia L.. In addition to the geographic conditions, climate, and dimensions of these islands, frequent traffic to these islands with Sakhalin by air and ship may promote the invasion of nonnative species.

Examining regional relationships in accordance with the introduced period, it is seen that 39 species (84.8%) that were introduced in the prehistoric to Japanese period cover all regions of Hokkaido, Sakhalin and the Kuril Islands. However, among the plants that invaded in Russian period, 79 species (51.3%) cover all these regions, while other species are still limited in distribution area. In the future, some of these plants, successfully naturalized, will enlarge their distribution. Some alien plants, which were newly found, seem to be introduced along with infrastructure constructions, and such plants may increase, especially along main roads and settlements. On the other hand, 59 species of naturalized plants in Hokkaido and part of Sakhalin have not yet introduced to the Kurils. Many of them have high rank of menace on the Blue list of Hokkaido (2010), A2 or A3, and efforts should be made to prevent their new invasion to the Kuril Islands.

4. Plants of careful treatment

Among newly invading plants, special attention should be paid to the following plants.

1) Rudbeckia laciniata L.

This species formed thick, dense colonies of 20–50m square around the mouth of the Tyatina River (Onnebetsu-gawa) at the southwestern foot of Mt. Tyata. These plants were also observed along the way to the region. Local people consider that they invaded during the period of Japanese settlement, or were introduced afterward during the period of Sovkhoz farm management. The species is considered to have originally escaped from cultivation. It is one of the most harmful naturalized plant in Hokkaido (A2), and in some localities in Hokkaido, it is periodically removed by volunteers.

2) Solidago gigantea Aiton

This species is included within 26 vascular plants on the list of “100 of Japan’s worst invasive alien species (Ecological society of Japan 2002)”. In Japan, the species was imported as horticultural purpose and rapidly enlarged its distribution area after naturalization, harming the natural environment; on Hokkaido, it seems more invasive than Solidago altissima L.. Some patches were observed in Kuril’sk (Shana), a central village on Iturup. They were observed along the main roads with a 2–3 km range, among settlements and in large meadow on the way to Lake Lebedinoye (Shana-ko). In the meadow, the plants formed almost a sole community of this species. As we did not see these plants in other areas, it seems to have invaded quite recently. It is recommended to remove it while its distribution is limited near the village.

3) Cakile edentula (Bigelow) Hook.

This is a plant originally native to eastern North America. The plant is known to be dispersed by sea currents, and is now found in coastal areas of North America, part of Australia and recently of Japan and adjacent regions. During the expedition, we found it in a coastal area of Kunashir Island in mass, and on Iturup sporadically. Though the effect of its occurrence is still unknown, it may compete with coastal vegetation as Salsola komarovičii Iljin, and possibly with Mertensia maritima (L.) Gray or Honckenya peploides (L.) Ehrh. var. major Hook. Details are in Fukuda et al.
We observed only a few individuals that were cultivated in a garden of Yuzhno-Kuril’sk (Furukamappu) on Kunashir. It can become a harmful invasive plant, as seen on Hokkaido (A2). On Hokkaido, it occurs widely under forests, especially around the Sapporo area. Careful treatment will be needed to prevent it from escaping.

Acknowledgements

We thank M. A. Antipin, I. G. Bobyr, A. Budaev, A. E. Loguntsev, and I. A. Nevedomskaya of the State Natural Reserve "Kurilskii" for their great help in our field expedition. This study was partly supported by Grant-in-Aid No. 21405009 from the Japan Society for the Promotion of Science to H.Takahashi.

References


福田知子1, Taran, A.2, 佐藤広行3, 加藤ゆき恵4, 高橋英樹5: 2010-2012年に確認された色丹・国後・択捉島の外来植物

2010年に色丹島、2009、2012年に国後・択捉島にて、外来植物の侵入状況についての調査を行った。これまで千島を含む極東地域から報告があった外来植物280分類群のうち、日本時代までに侵入したと思われるものは46、ロシア時代は154分類群であり、今回新たに21分類群を確認した。外来植物の侵入は戦後のロシア時代以降増加の傾向が見られ、特にキク科、イネ科植物の侵入が目立った。千島の外来植物は9割以上が近隣地域と共通し、約8割が北海道と共通する植物であった。島ごとに見ると国後は北海道と、択捉はサハリンとの共通種が多く、択捉には北半球に広く分布するが北海道などには侵入していない外来植物が多くみられた。国後・択捉では他の島よりも多くの外来植物が侵入していたが、その理由としては、住宅地・畑作などによって、外来植物が定着しやすい環境があること、栽培からの逸出の機会が多いことの他に、両島では空路・海路により、サハリン・北海道など他地域との交流が多いことも大きな要因であると考えられる。今回新たに確認した植物の中には、オオアワダチソウ、オオハンゴンソウなど、日本でも問題になっている植物が含まれ、今後も継続的観察が必要である。

(1)国立科学博物館植物研究部、(2)サハリン植物園、(3)北海道大学大学院農学院、(4)釧路市立博物館、(5)北海道大学総合博物館

Fig. 1. Distribution of Cakile edentula (Bigel.) Hook. around Japan. Large map indicate localities, reported for the occurrence of the plants by literatures (in round brackets), and by specimens (in square brackets). Small map with Kunashir & Iturup shows our result on population size of the plant. Specimen data provided by: Akita Prefectural Museum (AKPM), Fukushima University (FKSE), Ibaraki Nature Museum (INM) and National Museum of Nature ans Science (TNS), accessed through S-Net data portal, http://science-net.kahaku.go.jp/.
Table 1. Naturalized Vascular Plants in Honshu-Hokkaido - Sakhalin-Kuril Islands-Kamchatka.
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Period: 4
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<th>Our result 3</th>
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</table>

Remarks:
1) Two of the new alien taxa: 18. Anthoxanthum odoratum subsp. glabrescens and Elytrigia repens var. aristata are not included in the Table 1, because their distributions may be included in A. odoratum and E. repens respectively.

Plant name for the plants, which have not been recorded in Honshu and Hokkaido, are given in italic.

2) + means native plants, (+) means naturalized plants. - means the locality, where the species in question has not been recorded.

Distributions are checked by the following literatures.

- For the Kuril Islands:

- For Sakhalin

- For Kamchatka

2), 3) Abbreviations and marks:
Abbreviations: Hon.=Honshu, Hok.=Hokkaido, SHK=Shikotan, KUN=Kunashir, ITU=Iturup, Ur-At= from Urup to Atlasov (Islands between Iturup and Kamchatka), Sakh.=Sakhalin, Kam.=Kamchatka

State: AL=Alien, CU=escaped from cultivation, IN=Introduced, [NA]=naturalized.

Q-tity=quantity, VR=very rare, RA=rare, CR=comparably rare, OF=often, VO=very often.

When the plant is regarded as naturalized plant in Hokkaido, the rank of Bluelist of Hokkaido is noted (A2, A3, B).

Stae and Quantity follow Barkalov (2009).


* - * indicates that the plant is still out of range of the three islands of our research.
Fig. 2. Invasive alien plants, found during our expedition and their localities.

Aegopodium podagraria

Solidago gigantea subsp. serotina in Kuril’sk (Shana).

Localities, where invasive alien plants were found during our expedition 2009 — 2012.

A large colony of Rudbeckia laciniata, found along road to the mouth of the river Setonovskaya (Seoi-gawa). Photos by Norihisa Kondo.