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Possible biological control of some invasive plant species in Slovakia

MARTIN SUVÁK

Botanical garden P. J. Šafarik University, Mánesova 23, 043 52 Košice, Slovakia; fax: +421 55 6337353; tel.: +421 55 6331555; e-mail: msuvak@kosice.upjs.sk

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Abstract: Biological control of undesired invasive plants is taking into account in many countries. Such projects have been developed a long time ago but the success of their practical applications was different. It is very complex area requiring expensive studies and tests before an application. Especially the risk of undesired effects of non-native biological control agents must be considered. Such releases have been done in several non-European countries but theoretical studies are prepared for many other areas all over the world. This paper discusses some known pests and microbial control agents related to the most serious invasive plant species in Slovakia, such as goldenrods - *Solidago canadensis* and *Solidago gigantea*, giant hogweed (*Heracleum mantegazzianum*), Japanese knotweed (*Fallopia japonica*), Sakhalin knotweed (*Fallopia sachalinensis*), *Fallopia x bohemica* and Himalayan balsam (*Impatiens glandulifera*).

Keywords: biological control, invasive plants.

Introduction

The dramatic spread of non-native plant species troughout the world causes serious economic and environmental implications. Relevant authorities in respective countries take various measures to solve this problem. 47 invasive and 49 potentially invasive plant species are registered among 619 non-native plant species in Slovakia (Ministry of Environment of the Slovak Republic, 2003a). There are 7 invasive plant species selected in this paper for the purpose to outline possible biological control, they are mentioned in Slovak laws (Ministry of Environment of the Slovak Republic, 2003b) as serious problem: *Heracleum mantegazzianum* SOMMIER et LEVIER (Apiaceae), *Fallopia japonica* (HOUTT.) RONSE DECR. (Polygonaceae), *Fallopia x bohemica* (CHRTEK et CHRTKOVA) BAILEY (Polygonaceae), *Fallopia sachalinensis* (SCHMIDT) RONSE DECR. (Polygonaceae), *Impatiens glandulifera* ROYLE (Balsaminaceae), *Solidago canadensis* L. (Asteraceae) and *Solidago gigantea* AITON (Asteraceae). Of course, there are also other serious alien plant species in Slovakia, e.g. in ELIÁŠ (2000), but it should be a voluminous work to describe all potential biological control agents related to them. According to individual properties of selected plant species, especially to their reproduction and distribution pattern, there are folloving methods of supression allowed: mowing, herbicide application, grazing, pull out, excavation, ploughing, chopping and pruning laws (Ministry of Environment of Slovak Republic, 2003b). It is obvious that the enumerated measures can be applied only locally and with extensive costs. Moreover, most of invasive plants are able to regenerate easily or they can relatively rapidly re-appear from soil bank seed or from untouched areas.

Biological control of invasive plants in the world

Biological control of weeds is another method applicable to reduce negative impact of invasive plants. Though practical applications of this method are not common in Europe, there are other countries with remarkable success in using biological control agents to suppress plant invaders, especially Australia, New Zealand, USA and Canada. Different types of plants can be controlled by such methods – numerous terrestrial weeds (SYRETT et al. 2000) but also some aquatic ones too (FORNO & JULIEN 2000). For example a monument erected by Californian landholders to St John´s wort beetle (*Chrysolina quadrigemina* SUFFRIAN), the effective suppressor used against the invasive plant *Hypericum perforatum* L., is one of the best-known examples of successfull biological control (SYRETT et al. 2000). This type of interventions can be mostly regarded as classical biological control, i.e. the introduction of non-native organisms used for the suppression of the undesired ones – pests (or invasive plants in this case). The aim of this method is to introduce a new factor influencig fitness and competitive ability of intruders, so they could not be such serious problem any longer, i.e. to reduce their density below to an acceptable level. The potential risk to non-target native plant species should be eliminated in pre-release experiments (HOWARTH 2000). Modern genetics and molecular biology are used in the research of various biocontrol aspects laterly (EHLER et al. 2004). Scientists dealing with population biology and genetic variability of both, the alien plants (traits of resistence or tolerance) and biocontrol agents (virulence traits), can give us invaluable information to select proper species or even strains of potentially usefull long-acting biocontrol agents effective against the existing populations of plant invaders in local areas (e.g. BURDON & THRALL 2004, WAJNBERG 2004). Similarly, these information can also help us to predict better the results of biocontrol agent releases or to understand the past successes such as also the unsuccessull introductions too. EVANS & GOMEZ (2004) discussed it in the case of rust fungi, one of the most applicable group of potential biocontrol agents.

Well prepared programs of biological control of plant aliens could be highly cost-effective, permanent and self-sustaining method for their management (WITTENBERG 2004). But at first, the analyse and selection of bioagents related to individual plant invaders must be discussed. Following literature data shows that there are relatively enough source information for biocontrol programmes to develop eventually.

Goldenrods (*Solidago* sp.)

Non-native goldenrods have been introduced to Europe and Japan in about 1900 and even in former Czechoslovakia they were established as aggressive weeds causing problems especially in forest nurseries and reforestation areas as mentioned by ČAPEK (1971). This author have already discussed possible biological control methods against invasive goldenrods nearly 35 years ago.

Fontes et al. (1994) have collected 122 phytophagous species on 4 goldenrod species (*Solidago canadensis* var. *scabra* L., *S. fistulosa* P. MILL., *S. gigantea* AITON and *S. leavenworthii* TORR. et GRAY) around Gainesville, Florida. Only 14 (11%) of them are known to be restricted to goldenrods and *Aster* sp. (Compositae). 8 insect species are considered by authors as possible biological control agents of *Solidago* spp. for testing before introduction into Europe and Japan. Proposed insect species attack various parts of plants. They are root feeders (*Eurosta comma* (WIED.), Diptera: Tephritidae), leaf chewers (*Ophraella sexvittata* (LEC.), Copeoptera: Chrysomelidae and *Sparganothis distincta* (WALSING.), Lepidoptera: Tortricidae), leaf miners (Diptera: Agromyzidae sp. and *Cremastobombycia solidaginis* (FREY et BOLL.), Lepidoptera: Gracillariidae), leafgallers (*Asteromyia carbonifera* (OSTEN SACKEN), Diptera: Cecidomyidae) and flower and seed damaging agents (*Schizomyia racemicola* (OSTEN SACKEN), Diptera: Cecidomyidae and *Schinia nundina* (DRURY), Lepidoptera: Noctuidae).

Giant Hogweed (*Heracleum mantegazzianum*)

Phytophagous organisms connected to *H. mantegazzianum* in Slovakia were studied by CAGÁŇ (2001). More than 60 herbivorous insect species native to Slovakia were recorded by him on this plant. Especially *Liophloeus lentus* GERMAR (Coleoptera, Curculionidae) and some polyphagous caterpillars (Lepidoptera) were able to consume considerable amounts of leaves. Along this, the expeditions in the area of the giant hogweed origin in Caucassus were undertaken to find some potential biocontrol agents. The relatively greatest impact have had some recorded curculionid beetles (Coleoptera: Curculionidae) and some butterflies of *Depressaria* sp. Haworth (Lepidoptera, Oecophoridae).

Though *Lixus iridis* OL. (Coleoptera: Curculionidae) is one of the most common insects fed on *Heracleum mantegazzianum* in its native area, REZNIK (2003) does not confirm any significant negative impact on the giant hogweed during his investigation at the studied population under natural conditions.

HANSEN (2003) in his experiments have compared the growth of control plants with the growth of plants infested with the four species of control agents: the aphids *Dysaphis lauberti* BÖRNER, *Aphis fabae* SCOPOLI and *Cavariella theobaldi* (GILLETTE et BRAGG) and the thysanopteran species *Thrips tabaci* (LINDEMAN) under different soil conditions. All aphids were reducing the growth of *H. mantegazzianum* much more in the soils contained more fertilizer. Author suggested *Dysaphis lauberti* as the best option for controlling *H. mantegazzianum.*

NETWING (2002) have examined insect communities on this invasive plant in its native (Russia, Georgia) and invasive areas (Western Europe). Experiments with *Lixus iridis* feeding larvae, other curculionid root feeding larvae and Russian aphid *Dysaphis newskyi* Börner were done under controlled conditions to measure impact of these incect species on the giant hogweed growth and fitness. Other studies in climatic chamber show the impact of five different insects on *Heracleum mantegazzianum*: the aphids *Dysaphis newskyi*, *Cavariella theobaldi* and *Aphis fabae*, some thrip species (Thysanoptera) from Russia, and some still not identified Diptera species. This research is ongoing.

VOOGD et al. (2004) present biological measures for control this serious exotic weed in Denmark and the Netherlands. A novel mycoherbicide based on *Sclerotinia sclerotiorum* (LIBERT) DE BARY was used there in spring as a liquid mycelial suspension applied after regular cutting. Preliminary results show a substantial decrease in plant density of giant hogweed against the control plot next year. But these results must be verified in subsequent experiments in relation to biennal character of this plant species.

SEIER & DJEDDOUR (2003) discuss the potential use of 3 fungal pathogens related to giant hogweed in its native range. *Phloeospora heraclei* (LIB.) Petr. has seemed to be the most effective one but it can also be infective to non-target species, e.g. *Pastinaca sativa* L. (parsnip) and *Coriandrum sativum* L. (coriander). *Septoria heracleicola* KABÁT et BUBÁK resembles to previous species and they often coocure. The another revealed fungal species - *Ramulariopsis* sp. nov. is the first record for this species for the family Apiaceae and needs further investigations.

Japanese knotweed (*Fallopia japonica*), Sakhalin knotweed - giant knotweed, (*Fallopia sachalinensis*), *Fallopia* x *bohemica*

SHAW & SEIGER (2002) sumarize that in contrast to the situation in Europe and USA, damage to F. japonica by foliage-feeding invertebrates and pathogens was high in some of the Japanese sites. The authors mention 39 insect herbivore species,12 of them were found commonly.

Particularly apparent efects are caused by stem-mining Lepidoptera, found in the internodal sections of stems of the closely related *F. sachalinensis*, sawfly larvae (Hymenoptera) skeletonizing leaves and leaf-feeding chrysomelid beetle

Gallerucida nigromaculata BALY that seems to play a substantial role in the natural control of *Polygonum cuspidatum* (= *Fallopia japonica* = *Reynoutria japonica*). Also a suite of fungal pathogens can attack *Fallopia* species in Japan. One of them is the rust fungus *Puccinia polygoni-weyrichii* MIYABE. A combination of insect and fungal agents severely damages this plant in its native range, so members of *Fallopia* genus do not represent any visible weed problem in Japan.

Himalayan Balsam (*Impatiens glandulifera*)

This invasive riparian neophyte suppresses most of native riverside plant species but some grasses can compete against it. SCHAFFNER (2004) mentioned *Festuca rubra* L., *Dactylis glomerata* L. and *Agrostis stolonifera* L. as native species that seem to be able to reduce the average size of *Impatiens glandulifera* but not its number.

KOLLMANN & BAÑUELOS (2004) only recently registered for the first time a viral infection in several European provenances of this plant in a common garden experiment. The symptoms resembled Tobacco Rattle Virus and it led to reduced aboveground biomass of *I. glandulifera*. The infection was systemic and the virus could be transferred to two species of *Chenopodium* L. and several species of *Nicotiana* L.

Conclusions

Presented examples of research results related to regulating agents of some of the most serious neophytes in Slovakia show that there is the potential to use biological control methods. The successfull biological control programmes of invasive plants in the world are inspiring, some mistakes are also instructive. Anyway, the realization of such biological control programms must involve long term case studies, international cooperation and some legislative changes. Particularly the economic and environmental threat of individual invasive plant species, the effectiveness of other control measures and some potential risk from non-native biological controll agents must be taken into account in discussing possible biological control of invasive plants.

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