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BOOK OF PROCEEDINGS

XV International Scientific Agriculture Symposium
"Agrosym 2024"
Jahorina, October 10-13, 2024

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CONTENT

BIO-CONTROL OF THE FIVE MOST INVASIVE WEEDS AS A NARATIVE FOR THE SUSTAINABLE GOVERNANCE OF BALKAN NATURAL RESOURCES

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Abstract

Classical biological control remains the only tool available for permanent ecological and economic management of invasive alien species that flourish through absence of their co-evolved natural enemies. As such, this approach is recognized as a key tool for alien species management by the Convention on Biological Diversity (CBD), the European and Mediterranean Plant Protection Organization (EPPO) and the European Strategy on Invasive Alien Species (ESIAS). Successful classical biological control programs are present around the world, despite disproportionate attention being given to occasional and predictable non-target impacts. Despite more than 130 history cases in Europe against pests, no exotic classical biological control agent has been released in the EU against an alien invasive weed. This has occurred in the face and threat of increasing numbers of exotic invasive plants being imported everywhere almost taking over our National Parks, even „Virgin forests ", which is within first regime of protection areas in this region. The picture is the same on all continents. This paper considers the five most potential (with reference to Balkan) weed targets for classical biological control from ecological and socioeconomic perspectives using the criteria of availability of biological control agents, taxonomic isolation from European native flora and likely invasiveness outside Europe. Also, the paper considers the value to primary industry and horticulture (potential for conflicts of interest) regarding the five most invasive weed species (four woody species). Using standard entomology and phytopathology methods, results were presented in non-usual scale-number system, which was not done before, but in more plastic, interesting approach.

Key words: *Reynoutria, Ailanthus, Amorpha, Robinia, Bio-control.*

Introduction

Effective agents do not require regular application, as they spread naturally through the invader populations. Classical biological control has a historically tarnished reputation largely due to early unscientific and uncontrolled releases of vertebrate predators to control pests (e.g. releasing cats to control rats on islands). Even when this led to success, these predators also decimated native species. More recent cases of insect biological control agents spreading beyond their intended targets (e.g. the spread of *Harmonia axyridis* Pallas across Europe; Roy *et al.*, 2005). Plenty of cases also resulted from historically unregulated use of biological control against insect pests in Europe. Classical biological control of weeds now adopts a precautionary approach using the most specific antagonistic invertebrates and microorganisms against selected targets and follows best-practice scientific risk analysis and regulatory approval prior to release (Sheppard *et al.*, 2003). When conducted as such, negative effects have proved almost entirely predictable (Pemberton, 2000). In Europe, and on Balkan where weed biological control is still in its infancy, it will be important to identify initial weed targets that will have the widest ownership and be acceptable to even the sternest critics of biological control (Lonsdale *et al.*, 2001). With this in mind, the list was then assessed for biological control potential based on (i) historical success of biocontrol against these targets, ecological homologues and related species, (ii) taxonomic isolation of these weeds from geografic origines native flora (as a measure of risk of non-target damage), (iii) likelihood of suitable natural enemies being available as potential agents, (iv) target value to agriculture, horticulture and forestry (potential conflicts of interest) and (v) whether species were significantly invasive outside the area (opportunities for international collaboration; see Sforza & Sheppard, 2006). Impacts on European biodiversity could not be used, as so far data are available with reserve, butthey are presented where known. Each of five species“ independently considered these five questions“ and the number of positive responses was tallied for each species across all authors and used to prioritize the weeds for biological control. Where the number of positive responses was the same for different species, the relative geographical distribution and local abundance within and between closest countries was used to further prioritize the species. It was not possible to leave out the most important species with actual or potential conflicts of interest, because in a continent as culturally diverse as Europe nearly all alien species are valued by someone. It also has been reviewed why classical biological control of European exotic plants remains untested, considering problems of funding and public perception. Finally, consideration managed - of the regulatory framework that surrounds such biological control activities within constituent countries of the EU to suggest how this approach may be adopted in the near future for managing invasive exotic weeds in this region.

Materials and methods

The Risk Model uses numbers to represent the relative magnitudes of frequency, probability, and consequences, but the model cannot be considered “quantitative” in the sense of scientific accuracy. Using numbers simply allows various risk factors to be weighed systematically during the risk evaluation process. Description- the following description highlights the model for evaluating the risks associated with approving an operational plan for suppressing IS in sustainable and biodiversity preserving precondition. When an SDM receives an operational plan for approval the acceptability of the controlling- suppressing plan, must considered, all things reviewed, including following: The risks to a wide range of environmental, social and economic values of ISHE; The proposed mitigation of identified risks; The potential benefits of the proposed control or plan component; The Risk Model that follows offers guidance on the key steps in assessing risk. The approach leads decision-makers to draw risk conclusions by considering: Values of Concern; Potential Detrimental Invasive species hindering effect (Invasive species adverse effect; Frequency of Loss Event; Probability of Consequences Given a Invasive species adverse effect; Consequences of Loss Invasive species hindering effect -our „five all could be described like this, but finding perfect match for BC will connect the perfect pairs . Instructions -to ensure consistent application of this model, users should not assign numerical values other than those suggested in any of the categories. When in doubt choose the higher risk value. The initial entry in the Risk Assessment Matrix identifies the project or component under consideration. In the study of probability, invasive species hindering effect that will definitely happen are assigned a probability of 100 percent. Incidents that are impossible are given a 0 percent chance of occurrence, and everything else lies somewhere between these two extremes. Consider the following three levels of probability: Probable (7 points). The likelihood or probability of the consequence occurring is greater than 50 percent. Possible (4 points) The probability of the consequence falls between 20 and 50 percent. Unlikely (1 point) .There is less than 20 percent chance that the consequences will occur. The probability factors considered in selecting among the three broad categories of probability should be recorded in the comment space. Most Likely

Consequences - The next set of factors deal with the potential consequences of the plan or component, given a loss event, such as a landslide. In large part, this step requires decision-makers to consider the resources and other values that may be affected by the plan or component. Four categories of potential consequence are available: Catastrophic 10 points; Major 7 points; Serious 4 points; Minor 1 point. Briefly record the factors and features considered in making a determination of potential consequences. Total Risk Level-In the evaluation of risk, consider all three factors: Frequency of invasive species hindering effect presence, probability that consequences will occur, and the extent of consequences to things of value. Combining these related risk elements is a mental process that defies a strictly scientific or structured approach. However, the model suggests a simple method that has been adopted in other types of risk decision-making: Add the values for frequency and probability, then multiply the sum by the consequence value to determine a total risk score.

Results and discussion

Results suggest that each of a species, we are considering for matching is very competitive, resistant to contaminants or new control procedures, and one that can delay its dispersal until it has established a “beachhead” in the PA landscape. The beachhead patch ensures that there is a source for further migration into the landscape. The implication is that a fragmented or patchy environment will be more likely to contain an invasive because of the increasing number of areas that can be colonized and used as beachheads for further colonization. If the invasive can remain cryptic so that eradication efforts are limited until established in several refugee patches (PA habitats), the probability of a successful invasion should increase. The models confirm work by many other researchers (see Anderson *et al.*, 2004; Marvier *et al.*, 2004) that there is a clear interaction between the landscape, competing species, and the invasive species. Spatial structure must be incorporated if an understanding of the possible outcomes is to be factored into the risk analysis – special chalenge for Balkan countries.. The interaction between control measures and the native species demonstrated that only in extreme – high risk events influence had badly the outcome of the invasion (Watrud *et al*. 2004; Landis *et al*. 2000). Five alien plant species were identified through this process/ risk model as having positive responses to the posed questions. These are listed in Table 1.

Table 1. Exotic invasive plants in prioritized as potential biocontrol targets arranged by lines into groups of decreasing priority, but of similar priority within each group

Species Life form* Area of origin EU climate distribution Genus native to Europe

Species	Life form*	Area of origin	EU climate distribution	Genus native to Europe	Conflict of interest†	Past or current biological control programs/ publications
Fallopia japonica	Ge	Japan	Temperate	Yes	No	Yes
Fallopia bohemica(*Polygonum cuspidatum*)	Ge	Hybrid	Temp/Med	No‡	No	Yes
Amorpha fruticosa	Ph	N. America	Mediterranean	No‡	No	Yes
Ailanthus altissima	Ph	China	Temp/Med	No‡	No	Yes
Robinia pseudoacacia	Ph	N. America	Temperate	No	F	No

Legend for Table 1:
Freeman T.E.& Charudattan R. (1985)
*Ph = Phanerophyte, Ge = geophyte, Hy = hydrophyte, He = hemicryptophyte, Th = therophyte, Ch = chamaephyte.

Conflict of interest: †Past or current biological control programs/ publications
†O = current ornamental interest, F = value as forestry tree – simple aesthetic value of certain aliens weeds is not considered a conflict of interest as biocontrol will only reduce their density not eradicate them.
‡Family or subfamily also not native to Europe. 1. ***Fallopia japonica*** **(Houtt.).** 2. ***F. × bohemica*** **Chrtek & Chrtkova**

1. ***Fallopia*** (Polygonaceae) contains 24 species worldwide of which seven are considered weeds. ***Fallopia japonica*** **var.** ***japonica*** **(Houtt.) Ronse Decr.**, the most invasive clone (Bailey, 1994), is referred to as ***Reynoutria japonica*** **(Houtt.)** in some parts of Europe, Balkan also. Its firs appear on west of Serbia, then all across the country near roads and forest edges.
2. ***Polygonum cuspidatum*** **Sieb.& Zucc.** are also invasive, although their relative importance in Europe and Serbia is still being studied as partially *Fallopia japonica* and fact that mantioned hybrid appears to spread faster than either parent (Mandák et al., 2004), makes these two species among top five Serbia's and Balkan's aggressive aliens.

   Existing and potential biological control for both plants:
   Biological control is now recognized as the only longterm, sustainable solution to *Fallopia* spp. (Shaw & Seiger, 2002), but a full programme has been a long time coming. Since 2003, apredominantly UK consortium runthrough CABI has conducted field surveys in Japan, where the plant is heavily damaged compared with the exotic range. Selected insect sand range screening including a weevil (*Lixus* sp.), a psyllid (*Aphalara* sp.) (Fig. 1C), a rust (currently identified as *Puccinia polygoni amphibii* var. *tovariae* Arthur) and a leaf-spot disease (*Mycosphaerella* sp.) (Fig. 1D).
3. ***Amorpha fruticosa*** **L.** Origin, life history and ecology - According to some sources it was introduced in the Balkan Peninsula at the beginning of the twentieth century, precisely in 1900 (Petračić, 1938). False indigo bush L. (Fabaceae= Papilionaceae: Astragalae) reproduce generative, with pods, dispersed by water, and vegetative with a strong power of sprouting. Pods yield natural insect toxic chemical, and if demanding systematically control measures by combination of chemical and mechanical measures trailed this forest weed as woody plant are practically invincible (Gagić *et al*., 2008). Existing and potential biological control without finding solution that would exclude combined application of too expensive mechanical suppressing measures and environmentally eligible suspected pesticides it is possible to predict unstoppable expansion of this plant and facing with serious major problem in the near future. Table 2. as just seed enemies as bio control agents are more then enough for False Indigo Bush , because of power, or thanks to it'seed beetle opportunity even to attack dry seed so even 96% of whole samples could be destroyed.

Existing and potential biological control:

Table 2. Here just natural enemies of *A. fruticosa* seeds or it’s spermatophagous

Insect	***Biology and host preference of A. fruticosa pod pests***
***Acanthoscelides pallidipennis* Motschulsky. Coleoptera: Bruchidae: Bruchinae**	***Indigo bush weevil, bruchid beetle found feeding in pods (from 1/3 to 2/3, which is significant agent)***
***E. vesicularis*; *E. urosonus* (Hymenoptera: Chalcidoidea: Eupelmidae), in significant trio with *D. acutus*, (Hymenoptera: Chalcidoidea: Pteromalidae)**	ectoparasitoids of weevil larvae
***Syntomaspis* sp. and *Torymus* sp. (Hymenoptera: Chalcidoidea: Torymidae)**	possibility of seed predation and hyper parasitism, both need to be proven
***Tetrastichus* sp.; *Aprostocetus* sp (Hymenoptera: Chalcidoidea: Eulophidae)**	known to encompass parasitoids of the first and second order, so it is needed to proceed the research in order to determine their status -hyper parasitism phenomena demands experimental “tricks”
(Hymenoptera: Proctotrupoidea: Scelionidae)	Reared one specimen as fresh bruchid beetle egg parasite. Investigation needs to be continued in a goal of getting more specimens, data, status confirmation and species determination
(Hymenoptera: Proctotrupoidea: Diapriidae)	Hyperparasitoid of *Eupelmus* and *Torymus* genera, until now one specimen had been reared and prepared
Acari, Pyemotidae	Predators of weevil larvae and pupa
***Pyemotes* spp. (=*Pediculoides*) verticosus, National Academy of Sciences 1978**	

4. *Ailanthus altissima* (Miller) Swingle. *Ailanthus* (Simaroubaceae) contains 10 species confined to Asia and Australia of which A. altissima (from temperate and subtropical China), the only member of the 156 family in Europe and Balkan, it is considered an invasive species in most temperate regions of the world. Mediterranean coasts of Eurasian countries where it can suppress many native species through allelopathy (Heisey, 1996). *Ailanthus altissima* roots cause significant structural damage and exposure to the sap through cuts and abrasions in the skin can cause cardiac problems (Bisognano *et al*., 2005).

Existing and potential biological control:

Surveys conducted in China by USDA Forest Service identified nine specific plant pathogens and four arthropods (Zheng et al., 2004). Of these, two weevils [*Eucryptorrhynchus brandti* (Harold) and *Eucryptorrhynchus chinensis* (Olivier)], one heteropteran (*Orthopagus lunulifer* Uhler), three fungal pathogens (*Alternaria ailanthic* Zhang & Guo, *Aecidium ailanthi* , Zhuang and a *Coleosporium* sp.) have been selected for further study which could be through collaboration with Europe (Sheppard *et al*., 2006). A commercial stump treatment product (Stumpout^{TM}) based on the fungus *Cylindrobasidium laeve* (Pers.) *Chamuris* is used in South Africa killing 80% of treated stumps (Lennox *et al*., 1999).

5. Robinia pseudoacacia L. *Robinia* (Fabaceae) contains four species from North and Central America, all of which are considered as weeds worldwide. Now is extremely widespread in many habitats on Balkan and Serbia, also within Europe. Existing and potential biological control-more recently, classical biological control of weeds has also undergone significant criticism from within the ecological and evolutionary scientific community (Louda *et al*., 1997), despite there being only a few predictable non-target impacts and the release decisions for the causal agents being made at a time when society was more risk accepting.

Picture 1 *Mycosphaerella sp. Almost covers leaf of Reynoutria japonica (Houtt.)*

Picture 2 *Ailanthus altissima are sensitive to Eucryptorrhynchus sp. weevils*

Existing and potential biological control:
Three North American insects have already established on *R. pseudoacacia* in Europe. The gracillariid leaf mining moth, *Phyllonorycter robiniella* (Clem.), is found from Switzerland (since 1983) to Poland and Germany to Italy, whilst the cecidomyiid gall midge, *Obolodiplosis robiniae* (Haldeman) from the eastern USA, is ten years afo found in Italy, Slovenia and in the Czech Republic, in whole Europe along with the widely distributed locust borer *Megacyllene robiniae* (Forster) (Cerambycidae). *Phyllonorycter robiniella* causes premature leaf drop that negatively influences tree appearance and as such has itself been the target of a biological control program in Italy (Wojciechowicz-Zytko & Jankowska, 2005). Relatively high infestations of *O. robiniae* also because leaf fall, but the tree soon produces regrowth (Duso *et al*., 2005). *Megacyllene robiniae* tunnels serve as entry points for the fungus *Phellinus rimosus* (Berk.) Pilat (syn. *Fomes rimosus* (Berk.) Cooke) (Hoffard, 1992), which causes extensive wood decay and root rot (Hoffard, 1992) almost like *Vascular Wilt Disease* – almonst destroy alms and many oaks. Augmenting these species in Europe could provide one biocontrol strategy, but *R. pseudoacacia* also has other natural enemies in its native range that could be targeted at less desirable parts of the plant, e.g. the seeds. So today, different experiment with its serious seed predator *Bruchophagous robinie* Zer. are perform, within Entomology laboratories on Institute of forestry, Belgrade in a foal of maximum destroying generative host potential (Freeman & Charudattan, 1985). Something usually is cover mechanisms of infestation are the hyperparasitoids (Chalcidoidea: Eulophidae; *Tetrastichus*) phenomena so even results are newer superior. Even, some balanced results could be expected soon – lower generative potential and germinative obstruction.

Conclusions

Classical biological control offers environmentally sound and public good solutions to group of where affiliate some of Europe's worst alien five but strong and powerfull invasive plants. It would assist EU commitments to reducing chemicals in the environment and controlling alien invasive species, while applying the precautionary approach to intentional introductions of such beneficial exotic organisms. Europe has no shortage of potential targets for classical biological control using coevolved exotic natural enemies. Indeed, some of these weeds have been subject to successful biological control elsewhere. This review highlights just 5 of these and suggests, with the full support and in the context of the CBD and the ESIAS, the time is ripe for classical biological control of weeds to break into the mainstream, alongside public demand for action and national commitments to reduce chemical use and protect biodiversity. However, this will continue to be delayed if suitable government-assisted funding streams are

not established alongside processes for assessing conflicts of interest and raising public awareness on the issue of the costs of invasive species and the available solutions to them. Furthermore, the EU and its member states need to enact legislation and associated regulations as recommended under the ESIAS for restricting the importation of harmful and potentially harmful exotic organisms. Appropriate regulations can still allow releases of beneficial exotic species used in classical biological control, based on ISPM 3 and EPPO standards (2000) of risk assessment. By doing so, the EU would ensure all biocontrol agents proposed for release meet international risk analysis standards. The use of plant pathogens as classical biological control agents in the EU needs to be facilitated more than any other agent type through revision of the 91/414/EU directive, or at least its interpretation by member states, so that it is only applied as originally intended to formulated products. Rapid progress must be made, if all the invasive alien species management tools are to be available and Europe is to catch up with the rest of the world.
So for Balkan’s countries there’s a summary: *Fallopia* (both of) could be endengered the mostly by weevil (*Lixus* sp.) and serious cover by *Micosphaerella* sp. coverage on leaves; *Ailanthus altissima* are also sensitive to *Eucryptorrhynchus* weevils, *Amorpha* could be practicly destroyed through generative power by seed beetles and their parasitoids, and black locust could serious be attacked by combination of *Megacyllene robiniae* and fungus *Phellinus rimosus*, which causes extensive wood decay and root rot almost like Vascular Wilt Disease known as killer of Ulmus and oaks verticillosis.

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References

Anderson, M. C., Adams, H., Hope, B., & Powell, M. (2004). Risk assessment for invasive species. Risk Analysis, 24, 787–793.

Bailey J.P. (1994) Reproductive biology and fertility of *Fallopia japonica* (Japanese Knotweed) and its hybrids in the British Isles. In: The Ecology and Management of Invasive Riverside Plants (eds. LCD Wall, LEC Child, PMWade & JHBrock), 141–158. John Wiley & Sons, Chichester, UK.

Blossey, B., and R. Notzold. 1995. Evolution of increased competitive ability in invasive nonindigenous plants—a hypothesis. J. Ecol. 83:887–889.

Bossdorf, O., H. Auge, L. Lafuma, W. E. Rogers, E. Siemann, and D. Prati. 2005. Phenotypic and genetic differentiation between native and introduced plant populations. Oecologia 144:1–11.

Freeman T.E.& Charudattan R. (1985) Conflicts in the use of plant pathogens as biocontrol agents for weeds. In: Proceedings of the VI International Symposium on the Biological Control of Weeds (ed. ESDelfosse), 351–357. Agriculture Canada, Ottawa, Canada.

Gagić R., Glavendekić M. & Mihajlović Lj. (2008) *Acanthoscelides pallidipennis* (Coleoptera: Bruchidae), indigo bush seed parasite (*Amorpha fruticosa* L.) and its natural enemies in Serbia, ACTA HERBOLOGICA, Vol. 17, No. 2. pp. 195-201,

Landis, W. G. (2004). Ecological risk assessment conceptual model formulation for nonindigenous species. Risk Analysis, 24, 847–858.

Lambrinos, J. G. 2004. How interactions between ecology and evolution influence contemporary invasion dynamics. Ecology 85:2061–2070.

Lockwood, J. L., P. Cassey, & T. Blackburn. 2005. The role of propagule pressure in explaining species invasions. Trends Ecol. Evol. 20:223–228.
Louda SM, Pemberton RW, Johnson MT & Follett PA (2003) Nontarget effects – the Achilles' heel of biological control? Retrospective analyses to reduce risk associated with biocontrol introductions. Annual Review of Entomology 48, 365–396.
Lowe S., Browne M., Boudjelas S. & De Poorter M. (2000) 100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database. Invasive Species Specialist Group (ISSG), a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN), University of Auckland, New Zealand (http://www.issg.org/booklet.pdf).
Marvier, M., Kareiva, P., & Neubert, M. G. (2004). Habitat destruction, fragmentation, and disturbance promote invasion by habitat generalists in a multispecies metapopulation. Risk Analysis, 24, 869–878.
Mandák, B., Pyšek, P. & Bímová, K. (2004) History of the invasion and distribution of *Reynoutria* taxa in the Czech Republic: a hybrid spreading faster than its parents. Preslia, Praha 76, 15–64.
Petračić, A. (1938) „ *Amorpha fruticosa* L. as new and dangerous weeds in Posavina forests, Journal of forestry; Zagreb, 623-626
Shea, K. & Chesson, P. (2002) Community ecology theory as a framework for biological invasion. Trends in Ecology and Evolution, 17, 170–176
Sheppard, A. W., van Klinken, R.& Heard, T. (2005) Scientific advances in the analysis of direct risks of weed biological control agents to nontarget plants. Biological Control 35, 215–226.
Sheppard A. W. *et al*., (2006) European Weed Research Society Weed Research 2006 46, 93–117
Watrud, L. S., Lee, E. H., Fairbrother, A., Burdick, C., Reichman, J. R., Bollman, M., Storm, M., King, G., & Van de Water, P. K. (2004) Evidence for landscape-level, pollen mediated gene flow from genetically modified creeping bent grass with CP4 EPSPS as a marker. Proceedings of the National Academy of Sciences 101, 14533–14538.