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THE CONTENT OF PHENOLICS AND TANNINS IN NATIVE AND INVASIVE *SOLIDAGO* SPECIES

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Abstract. This paper deals with plant invasions in the Transcarpathian region of the Ukraine. Within *Solidago* genus, one native (*S. virgaurea*) and one invasive (*S. canadensis*) species were studied by measuring contents of phenolics and tannins. The results support the enemy release hypothesis. Because the invasive species can save its energy by aborting the phenolics production, and use this energy for other processes like growth or reproduction.

Key words: *Solidago virgaurea, Solidago canadensis,* invasions, alien plants, novel weapon hypothesis, metabolites, phenolics, tannins

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A lot of ecosystems around the world are threatened by invasions of biological organisms. Invasive species are usually non-native (introduced) organisms that grow and reproduce very quickly, and pose a big threat to the biodiversity of their surroundings (Biswas *et al.* 2007). However, the invasion is possible only if a current area is invasible.

This study has been done in the Transcarpathia territory which is a good example of an invasible area for invasive plants because of its moderate climate and nutrient-rich soils. Favorable conditions give the opportunity to colonize this territory by a lot of plant species (Pop 2003).

Within the genus *Solidago*, one native (*S. virgaurea* L.) and one invasive (*S. canadensis* L.) species were studied in July 2011. For each species the processing of leaf samples in five different locations were carried out. The locations were defined predominantly by different vegetation with different plant communities. Eight sets of samples (invasive/native) were taken from each location. In total, next leaf traits were measured both in field and lab conditions: leaf size (LS), specific leaf area (SLA), leaf dry matter content (LDMC), leaf carbon content (LCC), nitrogen content (LNC) and phosphorous content (LPC), C/N ratio, and N/P ratio. Moreover, three other traits were measured: stem specific density (SSD), specific root length (SRL), and mean root diameter (MRD). Four secondary carbon compounds were measured as well: phenolics, tannins, lignin, and cellulose. This publication is focused only on two traits – contents of phenolics and tannins.

It is hypothesized that invasive species have more phenolic acids than their native relatives, based on the novel weapon hypothesis (Callaway & Ridenour 2004). Phenolic acids are very important for growth, reproduction, pigmentation, tolerance and resistance against pathogens (Lattanzio 2006). Tannins are the most abundant phenolic acids occurring in plants. Tannins play a role in the defence mechanism of a plant against herbivorous insects (Barbehenn & Constabel 2011).

The term "phenolic" or "polyphenol" can be precisely defined as a substance which possesses an aromatic ring bearing one (phenol) or more (polyphenol) hydroxyl substituents, including functional derivatives (esters, methyl ethers, glycosides, etc.): as a general rule, the terms phenolics and polyphenols refer to all secondary natural metabolites arising biogenetically from the shikimate-phenylpropanoids-flavonoids pathways, producing monomeric and polymeric phenols and polyphenols (Lattanzio 2006). Several classes of phenolics have been

categorized on the basis of their basic skeleton: C6 (simple phenol, benzoquinones), C6-C1 (phenolic acid), C6-C2 (acetophenone, phenylacetic acid), C6-C3 (hydroxycinnamic acids, coumarins, phenylpropanes, chromones), C6-C4 (naphthoquinones), C6-C1-C6 (xanthones), C6-C2-C6 (stilbenes, anthraquinones), C6-C3-C6 (flavonoids, isoflavonoids), (C6-C3)2 (lignans, neolignans), (C6-C3-C6)2 (biflavonoids), (C6-C3)n (lignins), (C6)n (catechol melanins), (C6-C3-C6)n (condensed tannins) (Harborne 1980).

Total phenolic contents and total tannin contents was determined with the Folin-Ciocalteu method. The approach that was taken involves the following steps: extraction of the phenolic hydroxyl groups by a 50% methanol solution. A Folin-Ciocalteu reagent was used to colour the phenolics. A spectrophotometer at 760 nm was applied to measure the samples. The procedure was executed following the guidelines in "Total phenolics and tannins with the Folin Ciocalteu method" (Van Logtestijn, unpublished protocol).

The 2-way ANOVA analysis showed that *S. canadensis* produce significantly less content of phenolics and (almost significantly) less tannins. The total average content of the phenolics and tannins in *S. virgaurea* was bigger than in S. canadensis on 37 %.

The Principal Component Analysis showed the positive correlation between leaf LDMC and phenols/tannins content. It is known that LDMC is related to secondary C-compounds (lignin, cellulose, phenols, and tannins). A high LDMC corresponds to a high development of sclerenchyma, and as a result it corresponds to high level of cellulose, insoluble sugars and lignin concentrations. Also, high level of LDMC is often associated with herbivory (Poorter & Bergkotte 1992). Our results showed that LDMC is closer correlated to phenols/tannins content than to the lignin content. This correlation has presumably not been found earlier and an explanation for this still has to be found.

The higher phenolics and tannin content in the native species might be related to the enemy release hypothesis in the following way: invasive species have significantly less specific enemies than native species, because they simply left them behind in their native range. This is the reason why they might not need as much secondary metabolites as the native species do. Finally, invasive species saves its energy for growth or reproduction. However, to verify this hypothesis more investigations are needed.

References

Barbehenn R.V., Constabel C.P. 2011. Tannins in plant-herbivore interactions. *Phytochemistry* **72**: 1551–1565.

Biswas S.R., Choudhury J.K., Nishat A., Rahman M. 2007. Do invasive plants threaten the Sundarbans mangrove forest of Bangladesh? *Forest Ecol. Manag.* **245**: 1–9.

Callaway R.M., Ridenour W.M. 2004. Novel weapons: invasive success and theevolution of increased competitive ability. *Front. Ecol. Environ.* **2 (8)**: 436–443.

Lattanzio V., Lattanzio V.M.T., Cardinali A. 2006. Role of phenolics in the resistance mechanisms of plants against fungal pathogens and insects. *Phytochemistry: Adv. Res.*: 23–67

Poorter H., Bergkotte M. 1992. Chemical composition of 24 wild species differing in relative growth rate. *Plant Cell Environ.* **15**: 221–229.

Pop S.S. 2003. Natural resources of Transcarpathia. Spektral, Uzhgorod.

van Logtestijn R. Total phenolics and tannins with the Folin Ciocalteu method. *Unpublished protocol.*