Studying invasive plants in their native habitats improves understanding of their invasiveness: *Alliaria petiolata* and *Glechoma hederacea* as case studies

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Introduction

- Environmental filtering is the main mechanism that controls the establishment of alien plants into native plant communities (Divíšek *et al.* 2018).
- Traits of introduced species should be dissimilar from the traits of native species only to a certain degree to enable establishment and invasiveness at the same time (Divíšek *et al.* 2018).
- Several plants intrinsically have a high invasiveness capacity. In their native range some of them can be modest species, often occupying marginal habitats, and while commonly present, they only occasionally form dense stands.

For such species, information about their trait variability across native habitats is critically important to improve the understanding of their likelihood to become invasive and their invasiveness potential.

- We studied *Alliaria petiolata* and *Glechoma hederacea* native in Europe and invasive in North America.

Methodology

- Investigation of the variation in traits in native populations (NE Slovenia) across contrasting habitats: open (disturbed), forest edge and understory.
- Evaluation of various morphological, ecophysiological trait variability and species' habitat preferences. Competition through allelopathic potential of *A. petiolata* was tested with aqueous extracts and volatile compounds from leaves and roots on garden cress (*Lepidium sativum*) germination and seedling development.

Results

Trait variability in contrasting habitats of *A. petiolata:* significant differences in plant height, and % of leaves damaged by herbivory. Reproductive potential (number of fruit) was similar in understory habitat and ruderal site but significantly lower in forest edge (Table 1).

Table 1: *A. petiolata* population variability in relation to contrasting habitats and results of Kruskal-Wallis ANOVA and its multiple comparisons of mean ranks. ***P*<0.01.

Habitat	Plant height (cm)		Number of fruit		Undamaged leaves (%)	
	Mean ± s.d.	Post hoc	Mean ± s.d.	Post hoc	Mean ± s.d.	Post hoc
Forest understory	95 ± 26	a	27 ± 21	a	62 ± 27	a
Forest edge	79 ± 31	b	18 ± 15	b	73 ± 24	b
Ruderal site	76 ± 28	c	29 ± 27	a	82 ± 17	c
K-W ANOVA	H(2, N = 787) = 28.23**		H(2, N = 779) = 24.75**		H(2, N = 787) = 27.82**	

Allelopathic potential of *A. petiolata:* extracts significantly inhibited *L. sativum* seedling length and seedling's radicle development. The higher the concentration of the extract, the stronger the inhibition. In general, aqueous leaf extracts showed stronger inhibition than root extracts (Fig. 1). Volatile substances from *A. petiolata* leaves and roots also decreased germination and seedling growth (Fig. 2).

[Sajna (2017) Pol. J. Ecol. 65: 46-56.]

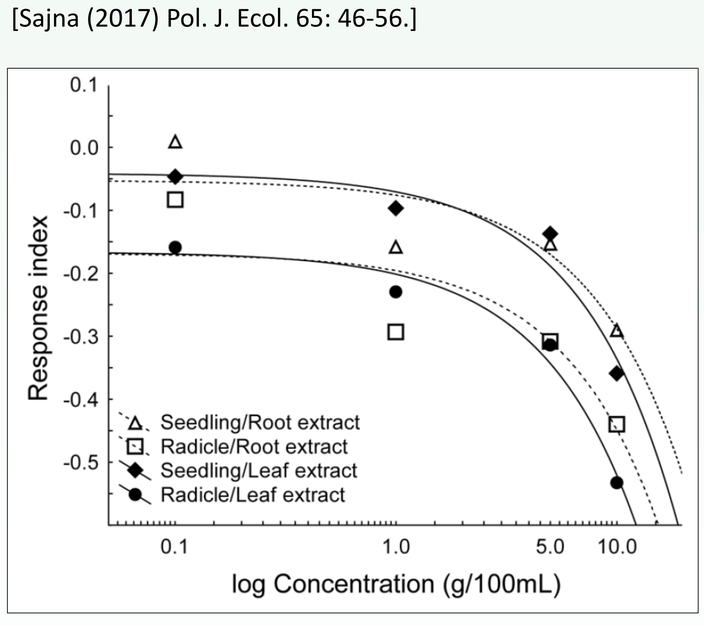

Fig. 1. Response index of *L. sativum* seedling and radicle length to increasing aqueous extract concentration of *A. petiolata* roots and leaves.

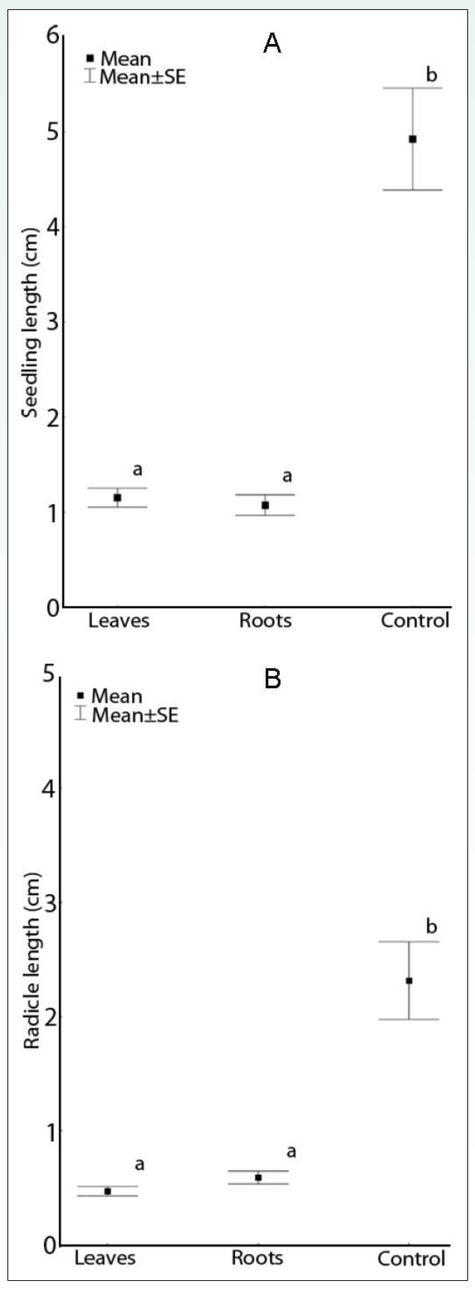

Fig. 2. Inhibitory effect of volatile compounds on seedling growth compared to control – (A) Total seedling length and (B) radicle length. Different letter indicate significantly different means ($P < 0.05$).

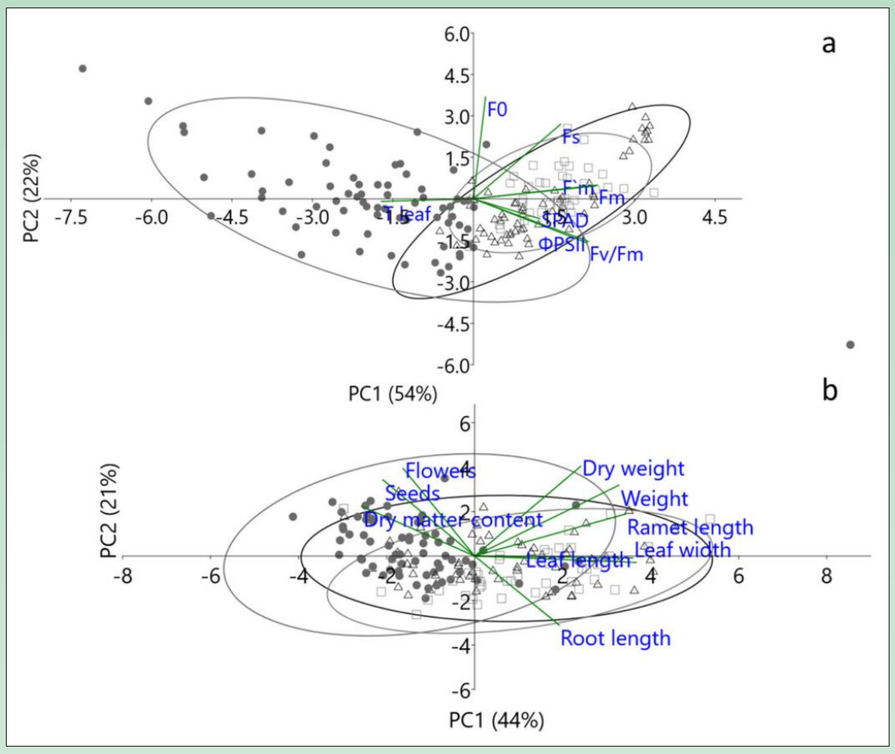

Fig. 3. PCA with 95 % confidence ellipses of (a) ecophysiological and (b) morphological traits in open habitat (dot), forest edge (triangle) and understory (square).

Trait variability in contrasting habitats of *G. hederacea:* significant differences in morphological (stolon length, fresh biomass, root length, dry matter content, leaf length, leaf width and flower and seed per stolon) and ecophysiological traits (steady-state fluorescence, actual efficiency of PSII, maximal fluorescence (Fmax) of light adapted leaves, Fmax of dark adapted leaves, potential efficiency of PSII, leaf temperature and chlorophyll content estimation) (Fig. 3). In general, significant differences were found between plants from the open habitats and those from the forest understory or the forest edge.

Environmental variables measured in three contrasting habitats were significantly different and consistent with the Ellenberg environmental values (Fig. 4)

[Sipek *et al.* (2020) Plant Biosyst. doi: 10.1080/11263504.2020.1727981]

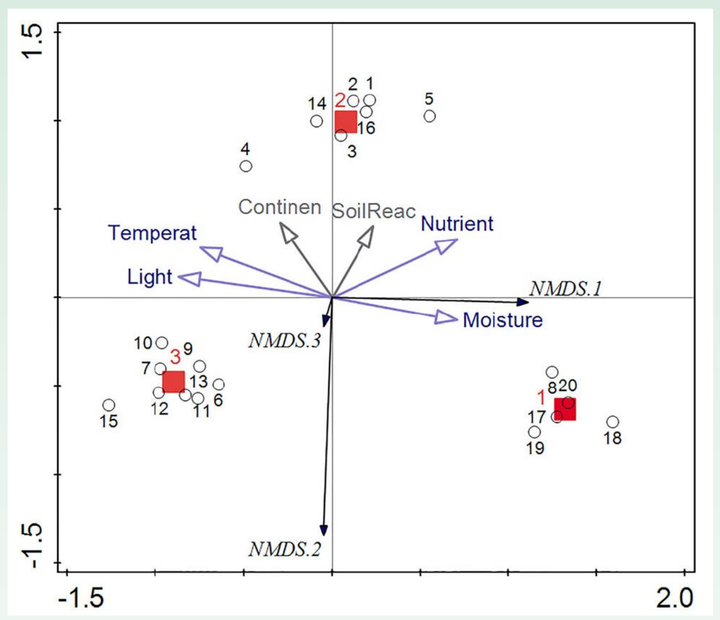

Fig. 4. Nonmetric multidimensional scaling (NMDS) plot showing 20 vegetation plots along a gradient of Ellenberg parameters: soil moisture, temperature, light conditions, and soil nutrients.

Discussion

- Native habitats where *A. petiolata* and *G. hederacea* are abundant, environmental conditions cover wide gradients indicating both species can tolerate conditions of low light and low moisture.
- Both species were most frequent in forest edge habitats, and *G. hederacea* shows similar habitat preferences in the introduced range (CABI 2019), but North American populations of *A. petiolata* are almost exclusively observed in forest understory (Nuzzo 1993).
- Both species can become established at open, disturbed sites, however, denser stands can be found in semi-shaded habitats.
- Allelopathic potential, confirmed for *A. petiolata* and demonstrated for *G. hederacea (*Rice 1986), is a widely present phenomenon that hampers the growth of other species, often regarded as one of the mechanisms helping invasive plants to succeed in new environments.
- **Both species exhibit characteristics reported for numerous invasive species: moderate tolerance simultaneously to shade and drought, ability to survive along forest edges and to enter forest understories; and some characteristics typical for ruderal plants.**

References

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