

Comparative ecology and coexistence of introduced and native congeneric forest herbs: *Impatiens parviflora* and *I. noli-tangere*

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Background and aims – *Impatiens parviflora* DC. is an invasive species which disturbs the natural vegetation composition in many European forests where it is frequently mixed with the native *I. noli-tangere* L. According to the literature, both species seem to share many biological attributes and have very similar ecological requirements. Extinctions have sometimes been reported for *I. noli-tangere*, and knowledge is lacking about the possible contribution of *I. parviflora* to this phenomenon.

Methods – In a large forest from central Belgium, we compared soil characteristics (inferred by the Ellenberg's indices) and strategies of the species from the recipient vegetation (according to Grime's system) between areas where (1) only one of the two *Impatiens* is present, and (2) both *Impatiens* grow together. In order to refine the knowledge of their ecological behaviour, we modelled the response of both species to these soil and community properties.

Results – Contrary to what is reported in the literature, we found that, in our study area, *I. parviflora* prefers soils of low base and N-status, it shows a preference for compacted soils, and it easily penetrates non-ruderal communities and dense groundlayers.

Conclusions – These findings suggest that the autecology of *I. parviflora* in western and central Europe is not very well known yet and deserves further studies. Our results also highlighted major differences in the ecological requirements of both species. We suggest that the regression of *I. noli-tangere* observed in many regions is not due to the invasion by *I. parviflora*, although additional studies are necessary to untangle this question.

Key words – alien, non-native species, comparative ecology, disturbance, *Impatiens*, small balsam, Ellenberg's indices, soil compaction, Grime's C-S-R plant functional types.

INTRODUCTION

Impatiens parviflora DC. is native of central and eastern Asia (Lambinon et al. 2004). It has been introduced in the 19th century in central and western Europe (Trepl 1984) where it can grow on a wide range of mineral soils (Coombe 1956), and in many different plant communities, such as *Quercus-Fagetea*, *Quercion*, *Alnetea glutinosae*, *Galio-Alliarietalia*, *Artemisietalia* (Trepl 1984). Despite its accidental introduction, *I. parviflora* is the only exotic plant being dispersed on a large scale in European forests. It is moreover one of the rare aliens to have penetrated stable vegetation (Trepl 1984). *I. parviflora* is an invasive species which, due to its mass occurrence, disturbs the natural vegetation composition in many localities (Dostálek 1997). It has been found that there is a relationship between the floristic

and structural degradation of the herbaceous layer in forest ecosystems and its resistance to the invasion of *I. parviflora* (Obidzinski & Symonides 2000, Chmura & Sierka 2007, Lysik 2008). Actions for its eradication have been reported in Poland (Adamowski & Keczynski 1999) and in Hungary (Csontos 1986).

The species has been rather well studied from the point of view of its response to light (Evans & Hughes 1961, Hughes & Evans 1962, Young 1981, Peace & Grubb 1982, Whitlam & Johnson 1982), temperature (Elias & Causton 1975), germination and dormancy ecology (Jouret 1974a, 1974b, 1976, 1977) or community structure and plant architecture (Elias 1992). In spite of the existing literature devoted to *I. parviflora*, the causes of its success in colonisation of new habitats are still not known (Obidzinski & Symonides 2000).

I. parviflora has been identified as a bioindicator for ambient ozone in central and eastern Europe (Manning et al. 2002, Manning & Godzik 2004). It has also been shown that the species' cover was favoured by enhanced nitrogen deposition (Falkengren-Grerup 1993). Moreover, *I. parviflora* is known to be a highly plastic species, i.e. a species that is able to adjust to different growth conditions and minimize the negative effects of decreases in resources (Elemans 2004). Furthermore, Heger & Trepl (2003) claim that, by avoiding root competition thanks to its shallow root system, *I. parviflora* has found an empty niche and that there is no need for a special "aggressiveness" of the plant.

As there are no characters which reliably distinguish invasive from non-invasive species, a more successful approach is the comparison of the characters that differ between pairs of closely related species of which one is invasive and the other not (e.g. Vilà & Weiner 2004, Feng & Fu 2008). We chose *Impatiens noli-tangere* L. in the framework of this study. *I. parviflora* is frequently mixed with the native

I. noli-tangere in moist woods (Coombe 1956). Large-scale extinctions have sometimes been reported for *I. noli-tangere* (Tichý 1997), and it rarely re-appears at sites from which it was lost (Hatcher, 2003). Although Tichý (1997) suggested that a decrease in soil moisture was the main cause for the complete disappearance of *I. noli-tangere* from a Czech forest over a 30-year period, knowledge is lacking about the possible contribution of *I. parviflora* to the progressive disappearance of *I. noli-tangere*. Whereas it has been suggested by some authors that *I. noli-tangere* reaches its maximum development in areas too wet for *I. parviflora* (Coombe 1956), other literature sources consider that *I. noli-tangere* grows more vigorously in a dry as opposed to a wet site in the same forest (Markov 1991). So, existing information on the autecology of both species can be conflicting. Furthermore, a literature review allowed us to highlight that both species seem to share many biological attributes (a.o. life form, height, gregariousness, reproduction, seed longevity, competitiveness) and that they also have very similar ecological requirements (same L, N, R Ellenberg indicator values, soil

Table 1 – Biological attributes and ecological requirements of *Impatiens noli-tangere* and *I. parviflora*.

¹According to Hatcher (2003) if not stated otherwise; ²according to Coombe (1956) if not stated otherwise; ³according to Ellenberg et al. (1991).

	<i>I. noli-tangere</i> ¹	<i>I. parviflora</i> ²
Biological attributes		
life form	therophyte	therophyte
height	20–180 cm	20–100 cm
competitivity	responds poorly to competition	responds poorly to competition
seed bank	transient	transient
seed production/plant	max. 2862 (counted)	up to 10,000 (estimated)
seed dispersal distance	up to 2–3 m	up to 1–2 m
reproduction	only by seed	only by seed
gregariousness	highly gregarious	highly gregarious
germination	early March	in the latter half of March
flowering period	early July - late August	late May - late September
mycorrhiza	no or weak	not recorded
root system	shallow and not extensive	shallow and not extensive
Response to environment		
light index ³	4	4
soil moisture index ³	7	5
soil reaction index ³	7	7
soil nitrogen index ³	6	6
temperature index ³	5	6
continentality index ³	5	5
salinity index ³	0	0
humus	mull	mull
soil	open-textured	open-textured
pH	4.5–5.2	4.5–7.6
disturbance	associated with soil disturbance	associated with soil disturbance
waterlogging	tolerant	intolerant
parasites	is attacked by various insects, fungi	free in Europe from animal attack

and humus type, soil base status, association with soil disturbance; table 1), which makes difficult the understanding of the invasive character of the one compared to the other.

In a beech-dominated forest from central Belgium where both species are present, we compared soil characteristics (inferred by Ellenberg's indices) and strategies of the species from the recipient vegetation (according to Grime's system) between areas where (1) only one of the two *Impatiens* is present, and (2) both *Impatiens* grow together. In order to refine the knowledge of their ecological behaviour, we also modelled the response of both species to these soil and community properties.

STUDY AREA

The research was conducted in the Sonian Forest, south of Brussels (50°47'N 4°26'E), which is a Site of Community Importance (Natura 2000 area, in fulfilment of the EC-Habitat Directive 92/43/EEC). The forest actually covers an area of 4383 ha. Some 20,000 years ago, sandstone and flintstone formed the upper layer in the area of the Sonian Forest. After the last Ice Age, this layer was covered with loess. Today, almost the whole surface of the forest (95%) is composed of a 3–4 m thick silt layer, which corresponds to the loess deposition. The forest ranges in altitude from 65 to 130 m a.s.l. The climate of the area is temperate and humid, with a growing season of 7 months (April–October). Mean annual temperature is 9.9°C, annual precipitation is 835 mm. The natural vegetation is a deciduous forest in which oaks (*Quercus robur* and *Quercus petraea*) and beech (*Fagus sylvatica*) are the main species (Herbauts et al. 1996). It is now composed of 74% beech (*Fagus sylvatica*) with only a few other woody species. Sixteen percent is occupied by oak stands (*Quercus robur*) and 8% by introduced conifers (*Pinus sylvestris*, *Larix decidua*, *Picea abies*) (Vanwijnsberghe 2002). *Impatiens parviflora* is very frequent in this forest where it locally covers extensive areas, sometimes in mixed stands with *I. noli-tangere*.

METHODS

Vegetation sampling

We used an existing database of vegetation plots (1–100 m²) taken at random between 1987 and 2003 within all vegetation communities of the forest (identified on the basis of forest stands, pedological, topographical and geological maps, as well as the ecological map of the ground cover and greenness degrees of the Brussels agglomeration in order to locate the communities with vernal component). For the present study, we only selected those plots where (1) only one of the two *Impatiens* is present (*I. parviflora* only: n = 392; *I. noli-tangere* only: n = 110), and (2) both *Impatiens* grow together (n = 49). This represents a dataset of 551 vegetation plots.

The species composition was characterized by classical phytosociological plots (e.g. Westhoff & van der Maarel 1973), which means that total coverage for each species (vertical projection onto the ground) was estimated visually.

Recording of soil compaction

Soil compaction measurements were available for 256 vegetation plots. Within each of these plots, three measurements of soil compaction were recorded using a cone-penetrometer (Eijkelkamp Agrisearch Equipment, The Netherlands), a device forced into the soil to measure its resistance to vertical penetration as frequently used to measure soil resistance (e.g. Seixas & McDonald 1997, Jansson & Wastelund 1999). The average value was taken for statistical analyses.

Data analysis

Species richness within each plot was calculated only for the 243 10 m² plots, in order to get comparable results by keeping the plot size constant. Since Braun-Blanquet cover-abundance values are not suitable for mathematical treatment, raw data were transformed by the corresponding cover percentage values (median of each scale interval): 0.2; 0.5; 2.5; 15; 37.5; 62.5 and 87.5 accounting respectively for r; +; 1; 2; 3; 4 and 5 (arbitrary values were taken for r, + and 1).

Species which are the most frequently associated with *I. parviflora* were derived by the Indicator Species method of Dufrêne & Legendre (1997), as available in the PC-ORD package (McCune & Mefford 1997). The method combines information on the concentration of species abundance in a particular group and the fidelity of occurrence of a species in a group. It produces indicator values for each species in each group, which are tested for statistical differences using a Monte Carlo technique (Dufrêne & Legendre 1997).

Soil nitrogen availability (N), soil reaction (R), soil moisture (F) and light (L) in the sample plots were estimated using Ellenberg's species indicator values. Because species are not always constant in their ecological requirements and ought in principle to have different indicator values in different parts of their range (Hill et al. 1999), we used the recalibrated Ellenberg's indicator values for the British Isles (phytogeographically closer to our study area), instead of the original ones which were defined for central Europe (Ellenberg et al., 1991). Weighted averages (WA) were calculated for each vegetation plot using the following equation:

$$WA = \frac{(x_1 y_1 + x_2 y_2 + \dots + x_n y_n)}{(x_1 + x_2 + \dots + x_n)}$$

Where x_1, x_2, \dots, x_n are the cover-abundance values of those species present in the relevé, and y_1, y_2, \dots, y_n represent Ellenberg's indicator values, either for nitrogen, reaction, moisture or light.

The quality of the humus layer was quantified by calculating a humus index for each sample based on the product of the weighted averages of nitrogen and reaction indices (Godefroid et al. 2005).

The composition of plant communities containing *Impatiens* species was also examined with special reference to species' ecological strategies (C-S-R model), according to Grime et al. (1988). Intermediate strategies were pooled according to Graae & Sunde (2000) using the following categories:

C+ (competitors): C, C/CR, C/CSR, C/SC

Table 2 – Species most frequently associated with *Impatiens parviflora*.

The table shows their indicator values (Percentage of perfect indication, based on combining the values for relative abundance and relative frequency), standard deviation (SD), and results of the Monte Carlo test of significance (p < 0.01).

	Observed Indicator Value (IV)	IV from randomized groups Mean	SD	P-value
<i>Impatiens noli-tangere</i>	43.3	11.2	2.47	0.000
<i>Epipactis helleborine</i>	41.1	3.4	2.22	0.000
<i>Dryopteris dilatata</i>	31.7	8.8	2.76	0.000
<i>Chrysosplenium oppositifolium</i>	30.6	7.8	2.81	0.000
<i>Fagus sylvatica</i>	29.4	8.9	2.76	0.000
<i>Anemone nemorosa</i>	29.0	4.8	2.77	0.000
<i>Hyacinthoides non-scripta</i>	28.9	3.7	2.53	0.001
<i>Quercus robur</i>	27.1	6.3	2.79	0.001
<i>Glechoma hederacea</i>	26.1	10.4	2.74	0.000
<i>Moehringia trinervia</i>	25.8	4.5	2.71	0.001
<i>Carex remota</i>	25.4	10.1	2.54	0.000
<i>Oxalis acetosella</i>	21.1	7.1	2.72	0.001
<i>Mentha aquatica</i>	21.1	7.2	2.74	0.002
<i>Arum maculatum</i>	20.7	4.2	2.56	0.003
<i>Millium effusum</i>	18.7	5.9	2.61	0.003
<i>Acer pseudoplatanus</i>	18.5	5.3	2.44	0.003
<i>Lysimachia vulgaris</i>	17.8	5.8	2.62	0.006
<i>Festuca gigantea</i>	17.8	4.2	2.32	0.000
<i>Rumex sanguineus</i>	16.3	6.9	2.54	0.007
<i>Carpinus betulus</i>	15.5	4.5	2.33	0.003
<i>Equisetum arvense</i>	14.8	4.5	2.34	0.004
<i>Salix caprea</i>	13.7	3.3	2.21	0.005
<i>Cisium arvense</i>	13.2	4.4	2.34	0.007

Table 3 – Species most frequently associated with *Impatiens noli-tangere*.

The table shows their indicator values (% of perfect indication, based on combining the values for relative abundance and relative frequency), standard deviation (SD), and results of the Monte Carlo test of significance (p < 0.05).

	Observed Indicator Value (IV)	IV from randomized groups Mean	SD	P-value
<i>Corylus avellana</i>	50.2	9.3	7.87	0.003
<i>Impatiens parviflora</i>	37.6	16.0	4.25	0.000
<i>Cirsium oleraceum</i>	29.4	14.1	6.04	0.037
<i>Scrophularia umbrosa</i>	28.9	12.2	7.18	0.031
<i>Oxalis acetosella</i>	28.1	11.2	7.31	0.035
<i>Lythrum salicaria</i>	25.1	8.8	8.81	0.043
<i>Sorbus aucuparia</i>	24.9	8.7	7.41	0.018

CSR+ (competitive and stress-tolerant ruderals): CR, CR/CSR, CSR, SC, SC/CSR, SR, SR/CSR
R+ (ruderals): R, R/CR, R/CSR, R/SR
S+ (stress tolerants): S, S/CSR, S/SC, S/SR.

Kruskal-Wallis non-parametric tests were used to test for differences in Ellenberg’s indices or C-, S- or R-strategists between communities containing *I. parviflora*, those containing *I. noli-tangere* and those where both species are present.

These statistical analyses were carried out with Statistica v. 6.0 (Statsoft Inc. 2001). The 0.05 level of probability was accepted as significant throughout the work.

Impatiens’s responses to environmental gradients were modelled by Generalized Linear Models (GLM; McCullagh & Nelder 1989), using the Canoco 4.5 statistical package (ter Braak & Šmilauer 2002). The response data are relative

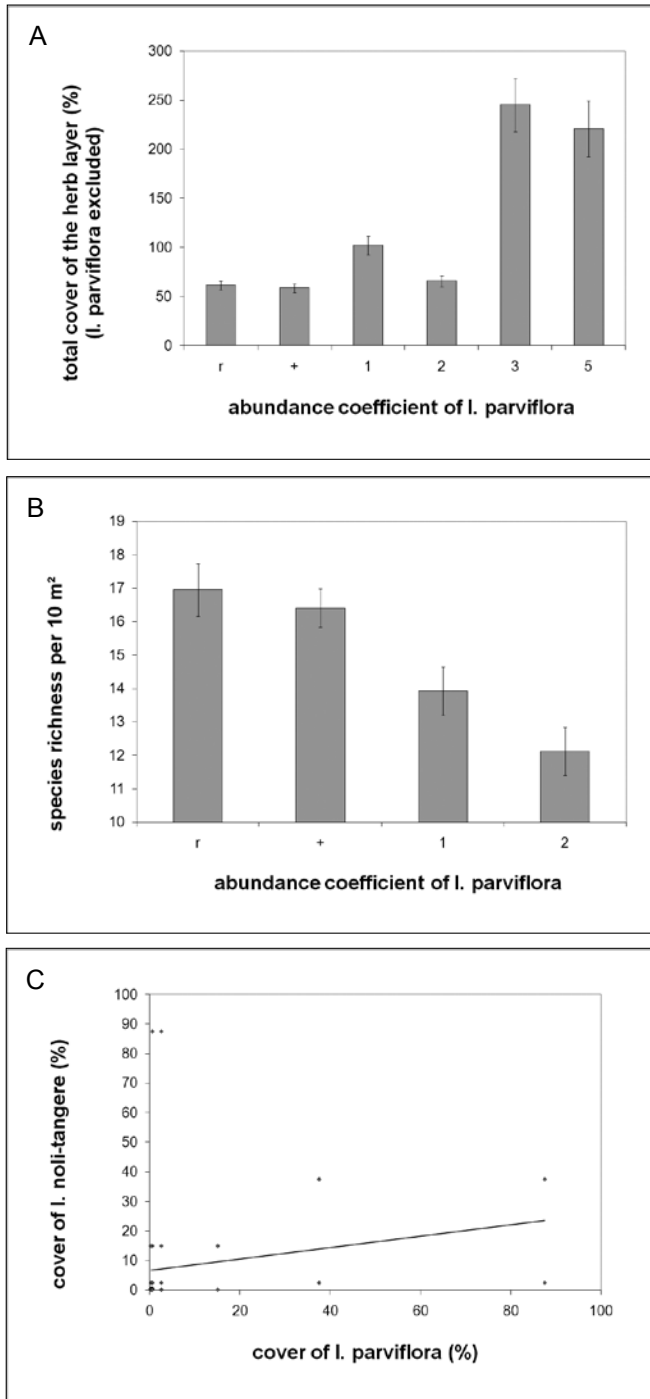


Figure 1 – Relationships between the abundance coefficient or cover of *Impatiens parviflora*. and: A, total cover of the herb layer ($H = 78.27$; $n = 441$; $P < 0.0001$; Kruskal-Wallis test); B, species richness per 10 m² in the herb layer (cover values 3 and 5 were not represented in this dataset) ($H = 25.02$; $n = 243$; $P < 0.0001$; Kruskal-Wallis test); C, cover of *I. noli-tangere* ($r_s = 0.40$; $n = 49$; $P = 0.0040$; Spearman Rank correlation).

covers (subjectively estimated percentages) and therefore a Poisson distribution was assumed with a logistic link function.

Nomenclature follows Lambinon et al. (2004).

RESULTS

Species which were the most frequently associated with *I. parviflora* are listed in table 2. Interestingly, *I. noli-tangere* was the species showing the highest fidelity, followed by *Epipactis helleborine*, *Dryopteris dilatata*, *Chrysosplenium oppositifolium*, *Fagus sylvatica*, *Anemone nemorosa*, etc. Species most frequently associated with *I. noli-tangere* are listed in table 3. In addition to *I. parviflora*, other species showing the highest fidelity are *Cirsium oleraceum*, *Scrophularia umbrosa*, *Oxalis acetosella*, *Lythrum salicaria* and *Sorbus aucuparia*.

I. parviflora had its highest abundance in communities having a dense herb layer (fig. 1A). Species richness in the herb layer significantly decreased with increasing abundance of *I. parviflora* (fig. 1B). However, it was not possible to highlight any negative effect of *I. parviflora* on the cover of *I. noli-tangere* (fig. 1C).

When examining inferred environmental conditions where both species grow together or separately, we found that light intensity, soil moisture, reaction, nitrogen and humus indices were significantly higher in stands containing *I. noli-tangere* compared with those containing *I. parviflora* (fig. 2). Surprisingly, we found fewer ruderal species in communities with *I. parviflora* compared to those including *I. noli-tangere*. Consequently, the opposite pattern was found for stress-tolerants as competitive species did not show any different contribution in these communities. Furthermore, stands where both *Impatiens* species are mixed were found to be similar to those comprising only *I. noli-tangere* (fig. 2).

Response curves for both species are given in fig. 3. *I. parviflora* showed monotonic reduction in abundance with increasing light intensity, soil moisture, soil nitrogen and humus index, whereas *I. noli-tangere* showed bell-shaped responses to these parameters. This implies significant differences in the optimum response found for each species, e.g. $L = 3$ and 5.5 , $F = 4$ and 7.5 , $N = 3$ and 6.5 , humus index around 5 and 30 for *I. parviflora* and *I. noli-tangere*, respectively. For soil reaction, both species showed bell-shaped curves with an optimum varying between $R = 4.5$ and 6.5 for *I. parviflora* and *I. noli-tangere*, respectively. While *I. noli-tangere* did not show a significant response to soil compaction, *I. parviflora* had positive growth response with increasing compaction. Furthermore, *I. parviflora* showed a progressively decreasing trend as the proportion of ruderal species increased, and it disappeared from communities containing more than 8% ruderals, while *I. noli-tangere* had an optimum development in vegetation types with 4% ruderals. *I. parviflora* was also better developed in stands comprising 7% stress-tolerants, against only 2% for *I. noli-tangere*.

DISCUSSION

In our study area, *I. parviflora* behaves as a shade plant, showing a significant preference for dry, acidic and nutrient-poor soil conditions. The optimum light and moisture indices found for the species in this study are close to what has been reported by Coombe (1956), Ellenberg et al. (1991) and Hill et al. (1999). However, our results related to soil pH and nutrient requirements of *I. parviflora* are not in accordance

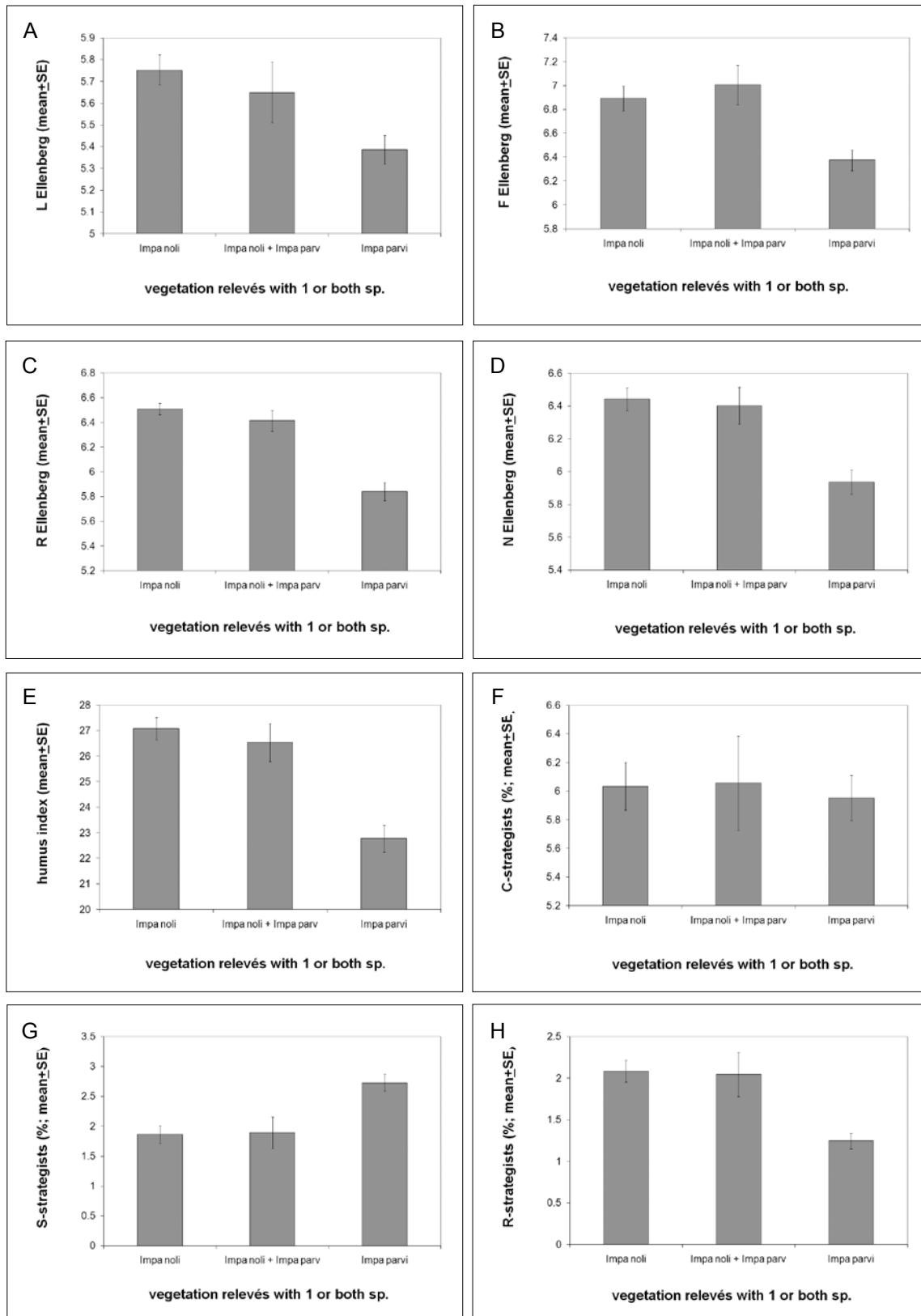


Figure 2 – Mean values (\pm S.E.) of Ellenberg's indices, C-, S- and R-strategists and humus index per plot where only one of the two *Impatiens* is present, and where both *Impatiens* grow together. Statistical results according to Kruskal-Wallis tests. A, light index ($H = 13.45$; $n = 295$; $P = 0.0012$); B, soil humidity index ($H = 28.33$; $n = 295$; $P < 0.0001$); C, soil reaction index ($H = 37.37$; $n = 295$; $P < 0.0001$); D, soil nitrogen index ($H = 24.05$; $n = 295$; $P < 0.0001$); E, humus index ($H = 32.89$; $n = 295$; $P < 0.0001$); F, competitors ($H = 0.36$; $n = 295$; $P = 0.8367$); G, stress-tolerants ($H = 16.95$; $n = 295$; $P = 0.0002$); H, ruderals ($H = 30.49$; $n = 295$; $P < 0.0001$).

with those found in the literature. Coombe (1956) reported that the species prefers soils of high base and nitrogen status,

i.e. Ellenberg values of 7 and 6 for R and N, respectively. After recalibrating the indices for the British Islands, Hill et

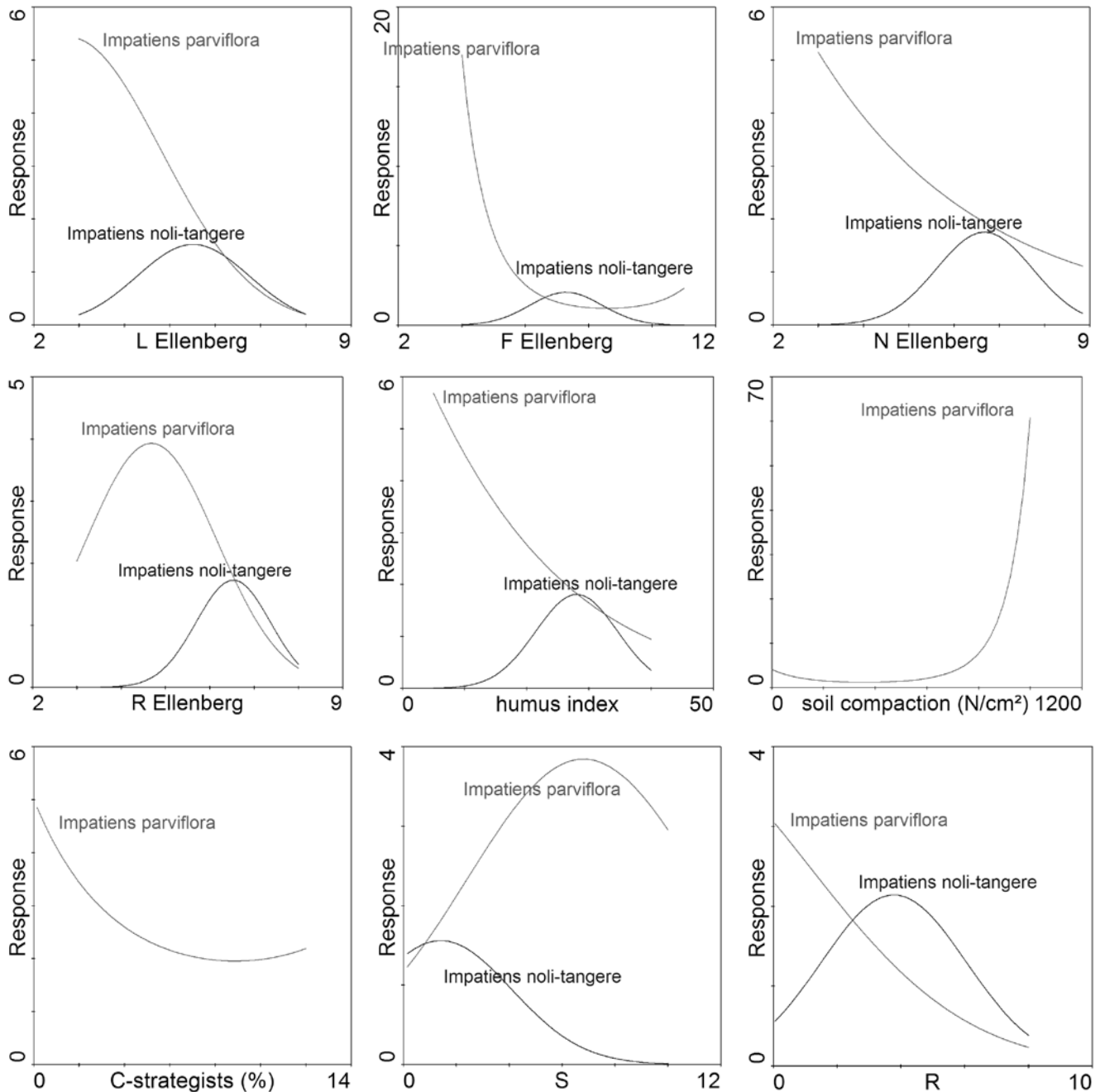


Figure 3 – Response (estimated percentage cover values) of *I. parviflora* DC. and *I. noli-tangere* L. to the average Ellenberg values (averages per plot), humus index (product of averaged Ellenberg R and N values), soil compaction, proportion of competitive (C), stress-tolerant (S) and ruderal (R) species from the recipient vegetation, modelled by Generalized Linear Models (GLM) using the Poisson response model with the second degree polynomial of x as an explanatory variable, and a logarithmic link function. L Ellenberg (*I. parviflora*: $F = 49.87$; $P < 0.0001$; *I. noli-tangere*: $F = 3.86$; $P = 0.0222$); F Ellenberg (*I. parviflora*: $F = 44.67$; $P < 0.0001$; *I. noli-tangere*: $F = 18.37$; $P < 0.0001$); N Ellenberg (*I. parviflora*: $F = 8.30$; $P = 0.0003$; *I. noli-tangere*: $F = 3.86$; $P = 0.0222$); R Ellenberg (*I. parviflora*: $F = 30.76$; $P < 0.0001$; *I. noli-tangere*: $F = 14.10$; $P < 0.0001$); humus index (*I. parviflora*: $F = 16.57$; $P < 0.0001$; *I. noli-tangere*: $F = 15.94$; $P < 0.0001$); soil compaction (*I. parviflora*: $F = 3.78$; $P = 0.0234$; *I. noli-tangere*: $F = 1.72$; $P = 0.1797$); C-strategists (*I. parviflora*: $F = 3.46$; $P = 0.0326$; *I. noli-tangere*: $F = 1.78$; $P = 0.1714$); S-strategists (*I. parviflora*: $F = 22.81$; $P < 0.0001$; *I. noli-tangere*: $F = 5.68$; $P = 0.0038$); R-strategists (*I. parviflora*: $F = 13.54$; $P < 0.0001$; *I. noli-tangere*: $F = 15.81$; $P < 0.0001$). The responses of *I. noli-tangere* to the proportion of competitors and to soil compaction are not shown because not significant at $P = 0.05$ level.

al. (1999) even obtained a value of 8 for the N-index of *I. parviflora*. In this study, our model showed that $N = 3$ and $R = 4.5$ were the best values for maximising the response of the species.

Modelling *I. parviflora*'s response to the humus index highlighted the species' preference for a humus of the moder type, whereas Coombe (1956) only cites a humus of the mull type. In our study area, the species also showed a better growth on compacted soils. This could be due to the fact that compacted soils are dryer than loose soils. Another explanation may be associated with its shallow and not extensive root system (Coombe 1956) which is able to develop in the humus layer and can benefit from the 2–3 cm of relatively uncompacted upper layer. This higher abundance on compacted soils is however not in agreement with existing knowledge that seeds become established only if the soil is loose in texture (Coombe 1956).

Our results also showed that *I. parviflora* was better developed in communities containing few ruderal species, while the species was known to be better represented in sites usually disturbed in various ways (Coombe 1956). Concerning *I. parviflora*'s poor competitiveness highlighted by the same author, our data did not allow us to support this view. Indeed, even if our model showed a better response of the species in communities containing fewer competitive species, *I. parviflora* also had a higher abundance in dense herbaceous understories. This means that a dense groundlayer does not necessarily provide a barrier to its development and that the species can compete with many species.

If we summarise these findings, we can say that, in our study area, and contrary to what is reported in the literature, *I. parviflora* prefers soils of low base and N-status, it shows a preference for compacted soils, it easily penetrates non-ruderal communities and dense groundlayers. These results suggest the fact that the autecology of *I. parviflora* in western and central Europe is highly variable, not very well known yet and deserves further studies.

Our results also highlighted main differences in the ecological requirements of both *I. parviflora* and *I. noli-tangere*, and therefore contributed to give some new insights to the autecology of both species. Modelling the response of both *Impatiens* species to environmental conditions allowed us to note that both species do show a very different behaviour. Ellenberg's values associated with an optimum development of both species differed from two units for R, 2.5 for L, three for F, and as much as four units for N. Contrary to *I. parviflora*, the values we found for *I. noli-tangere* are remarkably similar to those published by Ellenberg et al. (1991) and recalibrated by Hill et al. (1999). This means that the autecology of *I. noli-tangere* is much better defined than that of *I. parviflora*, probably because the latter shows a broader ecological amplitude. Indeed, striking is the fact that response curves of *I. noli-tangere* were all of the bell-shape type, while these of *I. parviflora* were mostly monotonic. This seems to confirm that *I. parviflora* is more able to adapt to various environmental conditions and minimize the negative effects of decreases in resources than *I. noli-tangere* does.

When comparing both species from the community point of view, our results showed that stands where only *I. parvi-*

flora was present were significantly different from those where *I. noli-tangere* developed, in terms of plant functional types (Grime's strategies) as well as habitat (inferred by Ellenberg's values). Furthermore, communities including both *Impatiens* species were found to be similar to those comprising only *I. noli-tangere*. This means that *I. parviflora* can perfectly colonise the habitats of *I. noli-tangere*, but that the contrary is not true, and it confirms the great adaptability of *I. parviflora* which has been highlighted by Elemans (2004). However, our models suggest that *I. parviflora* is not able to become invasive through the whole ecological range of *I. noli-tangere*. Indeed, in the studied area, the most well-lit, moist, nutrient-rich and basic stands were hardly ever colonised by *I. parviflora*, and if they were it was always with a very low abundance. It is therefore suggested that the regression of *I. noli-tangere* observed in many regions is not due to the invasion of *I. parviflora* which probably does not represent a major threat for the conservation of its native congeneric species. Additional studies are however necessary to untangle this question. Correlations with other factors should be investigated, such as for example the general decrease in soil moisture in many forest ecosystems.

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