Growth of invasive aliens *Landoltia punctata* and *Lemna minuta* in monocultures and mixtures under different nutrient conditions

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Introduction

Alien plant invasions have become serious environmental and socioeconomic problems and a hot topic of ecological research worldwide. *Lemna minuta* is an invasive aquatic macrophyte native to America and has widely spread in Europe including Belgium. *Landoltia punctata* on the other hand is a native to Southeast Asia and Australia and has been reported in The Netherlands but has not invaded Belgian water bodies. Lemnaceae are easily spread by water birds and so with time this species is expected in Belgium. Studies on invasive *L. minuta* on native *L. minor* are ongoing and preliminary results indicate competitive superiority of *L. minuta* over *L. minor*. Therefore, studies on *L. minuta* and *L. punctata* in competition would shed light on which of the two invasive species is a superior competitor and enable us anticipate its effects on the native species.

Objectives

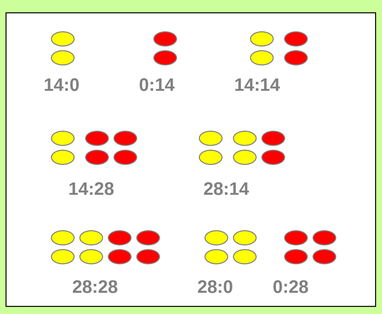
• Which alien species is a superior competitor?

Figure 1. *Landoltia punctata* (larger species) and *Lemna minuta* (smaller species).

• In determining the composition change in mixture, what is the role of
- species identity
- species initial biomass
- nutrient enrichment

Materials and Methods

Complete additive design



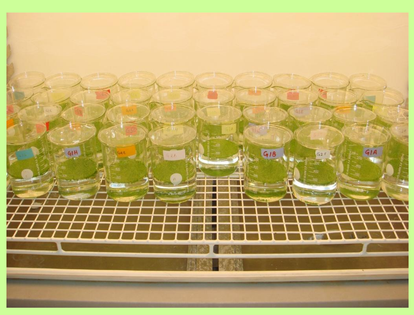


Figure 2 Complete additive design consisting of factorial combinations of initial densities, followed in low and high nutrient experiments, under constant light and temperature . Left the design in theory, right in practice.

Analysis

• Relative Growth Rate(RGR)

$$RGR = \ln (Y_i/y_i)/t$$

• Difference in RGRs:

$$RGRD = RGR2 - RGR1 = \frac{\ln (Y_2/y_2) - \ln (Y_1/y_1)}{t}$$

Y_i = final stand biomass
y_i = initial stand biomass
i = species 1 or species 2
ln = natural logarithm
t = time

Preliminary results

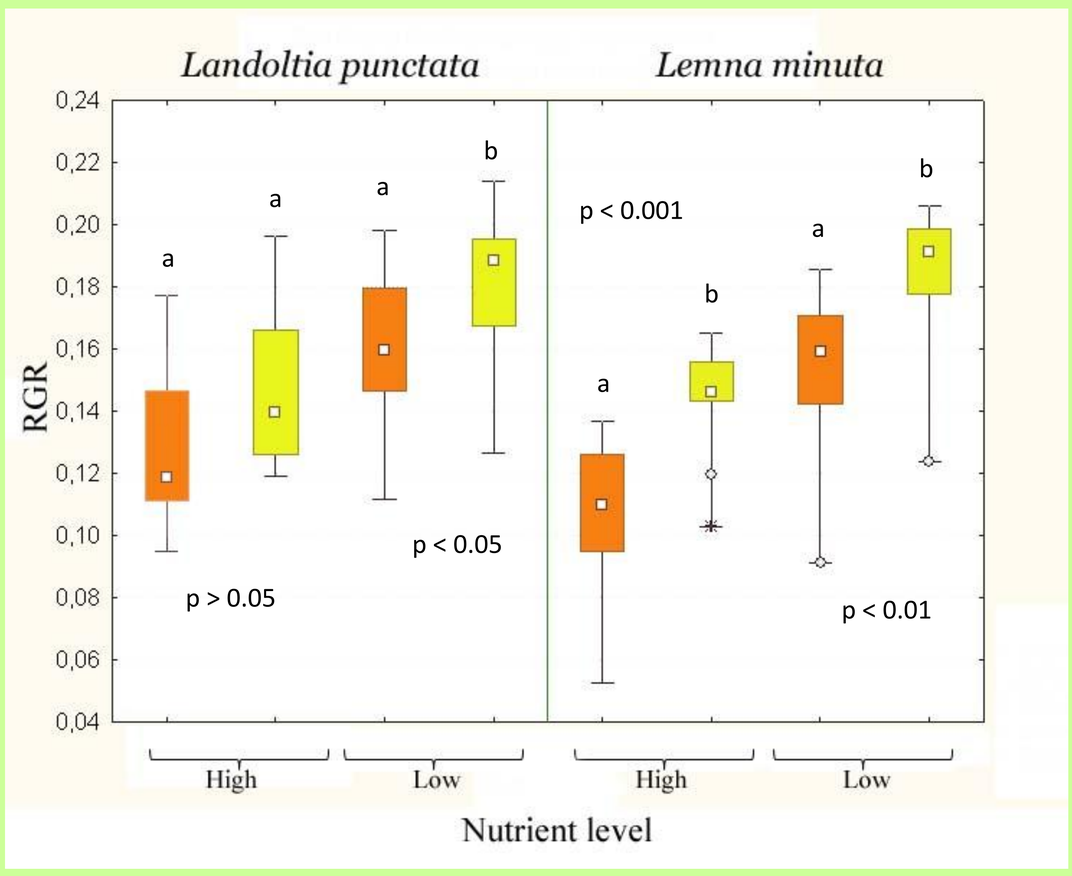


Figure 4 Relative growth rate (RGR) of *L. punctata* and *L. minuta* monocultures and mixtures in high and low nutrient level. (Box & Whisker plot) *L. punctata* is shown left, *L. minuta* right. Monocultures are indicated in yellow, mixtures in orange. represents the median, the box represents the interquartile range and the vertical lines indicate the minimum and the maximum values. Outliers are represented by , extremes by *. Medians with different letters indicate significant differences between monocultures and mixtures within each nutrient level.

Table 1 Estimated linear equations for plant species relative growth rate (RGR) and difference in relative growth rate (RGRD) between *L. minuta* and *L. punctata*.

Species	Variable	Linear model	R^2
L. punctata	RGR	$Y = 0.18708 - 5.59719 (X_1) + 1.14898 (X_2) - 0.02954 (T)$ {32.78} {-11.64} {2.00} {-8.32}	0.86
L. minuta	RGR	$Y = 0.19962 - 0.48047 (X_1) - 6.62938 (X_2) - 0.04636 (T)$ {31.05} {-0.82} {-9.78} {-11.22}	0.87
	RGRD	$Y = 0.00478 - 5.36019 (X_1) + 7.34105 (X_2) + 0.00713 (T)$ {0.54} {-7.11} {8.19} {1.29}	0.80

X_1 is the initial biomass of *L. punctata*, X_2 is the initial biomass of *L. minuta*. T is the effect of nutrient treatment. t-statistics are indicated in parenthesis, significant values (greater than 2) are indicated in red.

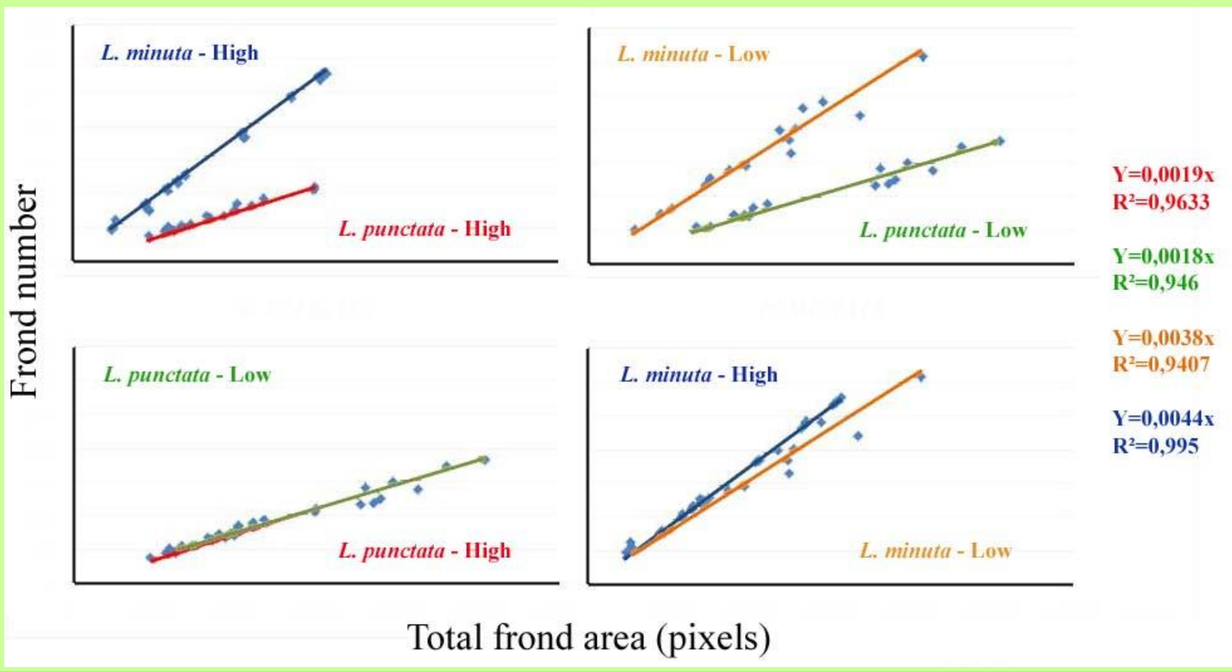


Figure 3 Scatterplots of frond number versus total frond area of *L. punctata* in high (red) and low (green) nutrient level, *L. minuta* in high (blue) and low (orange) nutrient level. R^2 values and equations are indicated in matching colours. Correlation between frond area and frond number for both species in both nutrient levels ranges from 0,91 to 0,98 and is significant at $p<0,05$.

Conclusions

• Stronger *intra*specific relative to *inter*specific effects on the RGR of either species
•There is a significant positive correlation between frond area and frond numbers for both species in both nutrient levels.
• Species effects greatly influenced the difference in growth rate of both species
• High and low nutrient level favored *L. punctata* relative to *L. minuta*
• Increasing the initial biomass of *L. minuta* enhanced RGRD, increasing the initial biomass of *L. punctata* had the opposite effect

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• **Species influence was the main determinant of change in this species mixture**

• **We predict *Landoltia punctata* can potentially outcompete other Lemnaceae species**