Comparative performance between Invasive Alien *Eichhornia crassipes* and Native *Ludwigia stolonifera* under nutrient non-limiting conditions: Lake Naivasha, Kenya

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Introduction

The spread of invasive alien species (AIS) is now recognized as one of the greatest threats to the ecological and economic well-being of planet. Invasive plants often grow aggressively and form monocultures by outcompeting less vigorous native plants for light and space. Lake Naivasha has undergone several ecological changes, which includes introduction of non-native species of both flora and fauna. *E. crassipes* (Mart.) Solms, is an indigenous monocotyledonous species of tropical South America that has become a widespread exotic pest of tropical zones. The species first appeared in Lake Naivasha in 1988. The species is now well established on the shore of L. Naivasha and forms floating mats. The floating mats of *E. crassipes* are often colonized by other aquatic, wetland and terrestrial plant species. *L. stolonifera* is a native creeping emergent macrophyte and is one of the most frequent herbaceous species that colonizes the floating mats of *E. crassipes.*

Objective

The present case study was conducted to investigate the impacts of the highly invasive *E. crassipes* (competitive effects) on native plants with *L. stolonifera* as the model native macrophyte. The role of species identity and species influence in determining composition change for the two species was also investigated.

Methods

Experiments

Statistical Analysis

One-way ANOVA on root/shoot ratio and relative growth rate (RGR) between the monoculture and mixture was done. Relative Growth Rate Difference (RGRD) model for two species in mixture was fitted with an aim of revealing which species wins the competition and the role of species identity and species influence in composition change for the two species.

RGRD Model

The average relative growth rate (RGR) for the *i*th species (for i = 1 or 2) was calculated as $\ln\left(\frac{Y_i}{y_i}\right)/t$ where, Y_i is the stand biomass for the species at the end of the experimental period, y_i is its biomass per stand at the start of the experimental period, t is the duration of the experiment and ln is the natural logarithm.

A comparison of the change in composition for the two species is related to a difference in their RGR's. Hence, the differences between the RGR's for both species is calculated as

$$\ln\left(\frac{Y_2\,y}{y_2\,Y}\right)-\ln\left(\frac{Y_1\,y}{y_1\,Y}\right)=t(RGR_2-RGR_1)$$ or where $$RGRD=RGR_2-RGR_1=\left[\ln\left(\frac{Y_2}{y_2}\right)-\ln\left(\frac{Y_1}{y_1}\right)\right]/t$$

Using multiple regression, RGRD was modelled as

$$RGRD=b_0+b_1y_1+b_2y_2+b_3T+\varepsilon$$

where b1 and b2 measure the effects of changing the initial biomass of the first or second species on RGRD, b_0 is the constant difference in average RGR of the two species over the experimental period and b3 measures the effects of treatment (in this case zero for no treatment).

Results

Biomass accumulation and allocation

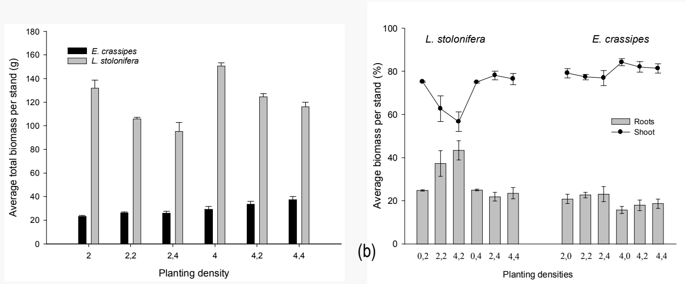

Fig. 1 (a) Average total biomass of *L. stolonifera* and *E. crassipes* grown in different densities over the experimental period (b) Percentage of shoot and root biomass of *L. stolonifera* and *E. crassipes* grown in different densities over the experimental period. Error bars represent ± SE of the means.

Species identity and species influence

$RGR_{Ludwigia}$ = **0.0354-0.0022*X$_1$-0.0004*X$_2$** $RGR_{Eichhornia}$ = **0.0228**+0.0002*X$_1$-**0.0019*X$_2$** $RGRD_{LE}$ = ***0.0126-0.0024*X$_1$+0.0015*X$_2$***

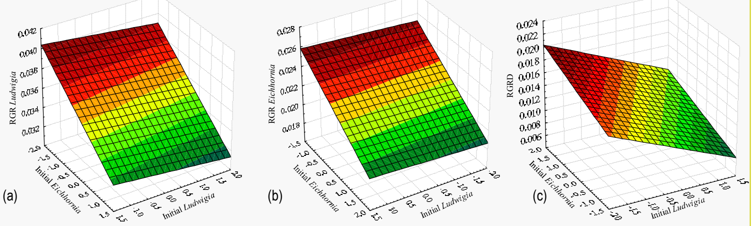

Fig 2. Estimated models for relative growth rate (RGR) of (a) *L. stolonifera* (b) *E. crassipes* and (c) for differences in RGR (RGRD) between *L. stolonifera* and *E. crassipes* over growth period. The regression equation for each species RGR and RGRD are shown above and bold type indicate significant coefficients at t statistic greater or equal to 2.

Change in species proportion

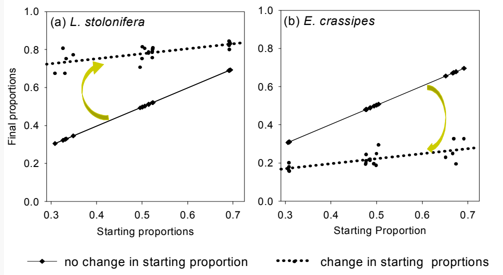

Fig 3. Final species proportion relative to initial proportions **(a)** *L. stolonifera* and (b) *E. crassipes* .

Conclusion

- *L. stolonifera* gained more biomass than *E. crassipes* over the growth period due to its higher RGR
- Both species allocated more shoot than root biomass
- Increasing the initial density of *E. crassipes* had a significant effect on RGR and root/shoot ratio of *L. stolonifera*
- Species identity coupled with strong intra rather than interspecific effects on a species own RGR enabled *L. stolonifera* to outperform *E. crassipes* and hence the shift of the final composition towards *L. stolonifera*

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