Case study 3 - Effect of intraspecific trait variability in time on the ranking of species trait values

Description

We considered a theoretical trait value for two co-existing species (each with 10 individuals) on a time interval equal to 20 units of time. Species performance with regard to this trait was compared for 4 models incorporating different levels and forms of ITV (see *How much ITV is there in the study system?* and *How do traits vary*?).

(a) The first model (no ITV) illustrated the classical trait-based approach which does not take into account ITV: species 1 and 2 are characterized by different mean trait values TV_{jit} (j=1, 2) that are constant over time *t* and between individuals *i* within the species: $TV_{2it}=\mu_2>TV_{1it}=\mu_1$.

(b) The second model (Temporal ITV) assumed a temporal variability V_{Tj} of the species trait value (e.g. due to climatic factors) affecting all the individuals of a species in the same way: $TV_{jit} = \mu_j + T_t$ with $T_t \sim N(0,V_{Tj})$.

(c) The third model (Spatial and Temporal ITV) supposed an additional spatial individual variability V_{Sj} of the species trait value: $TV_{jit} = \mu_j + T_t + S_i$ with $S_i \sim N(0,V_{Sj})$.

(d) Finally, the fourth model (Unstructured ITV) assumed an unstructured ITV entering the model through a residual variance σ^2: $TV_{jit} = \mu_j + \varepsilon_{it}$ with $\varepsilon_{it} \sim N(0, \sigma_j^2)$.

For each model, we run 500 trait value simulations and we compared the percentage of occurrences for which the species hierarchy was inverted (Sp. 1 > Sp. 2, see *How to proceed for multiple study species?*). For this example, we fixed the parameters to the following values: $\mu_1=3$, $\mu_2=5$, $W_1=W_2=2$, $V_1=V_2=3$ and $\sigma_1^2=\sigma_2^2=W+V=5$.

Conclusion

With this theoretical approach, we show (i) how ITV can be structured in space and time and (ii) how ITV can potentially modify the species performance ranking and thus potentially the between species competition if the trait under consideration is vegetative height for instance. (Sp2>Sp1 in mean and in general, but might be Sp1>Sp2 depending on when and on which individual measured)

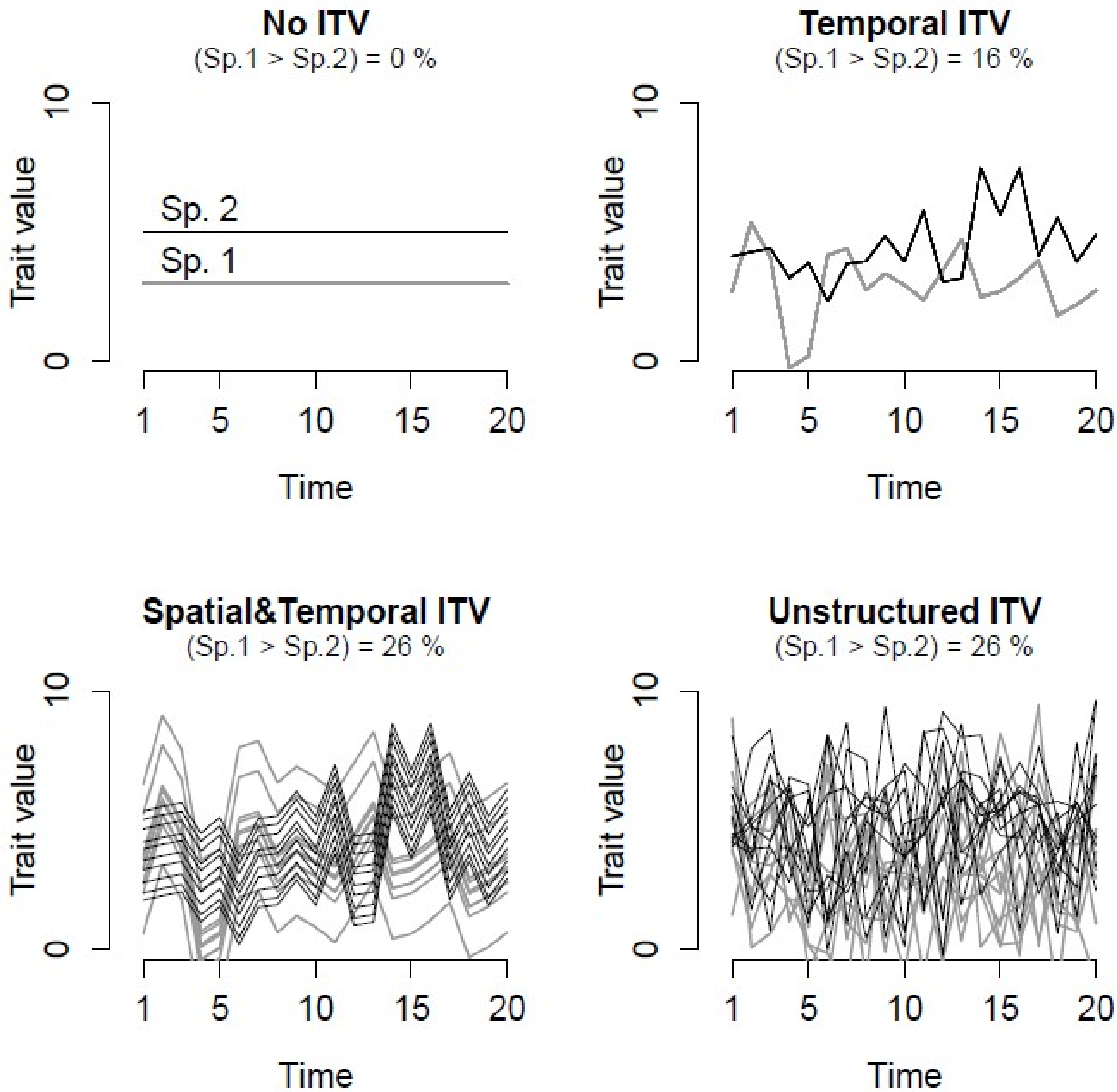
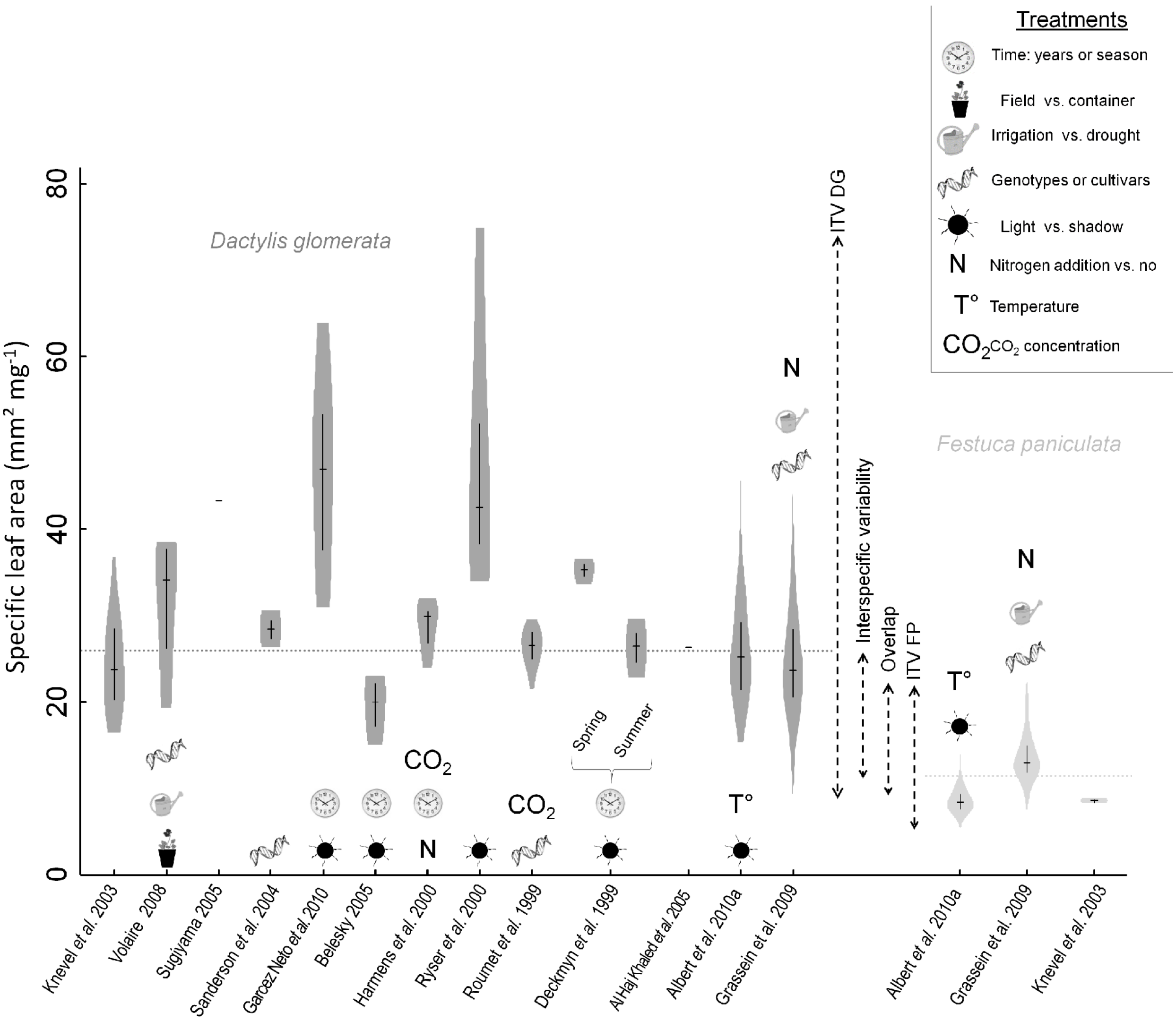


Fig. S1 - Effect of intraspecific trait variability in time on the ranking of species trait values

Figure S2. Intraspecific trait variability (ITV) for the specific leaf area of two grasses: *Dactylis glomerata* and *Festuca paniculata*

D. glomerata is a fast-growing species (acquisitive strategy) and *F. paniculata* a slow-growing species (conservative strategy), both being perennial, broadly-distributed graminoids. Distributions of specific leaf area (SLA) values for *D. glomerata* (left, dark grey) and *F. paniculata* (right, light grey) have been gathered from the literature and are represented with violin plots. Violin plots are a combination of a boxplot and a kernel density plot (a non-parametric way of estimating the probability density function of a random variable). They present (i) the density of the data estimated by kernel method (in grey) (ii) the median value (black dash) (iii) the inter-quartile range: between the first and the third ones (black segment). Each distribution represents a different study. The environmental and genetic factors ("treatments") resulting in ITV, are given as symbols below (or above). The four vertical arrows represent respectively: ITV for *D. glomerata*, the difference between SLA mean values for *D. glomerata* and *F. paniculata* (interspecific variability) and the overlap between the overall distributions of SLA values for the two species. Mean SLA values are very different for the two species: 25.9 mm^2 mg^{-1} for *D. glomerata* vs. 11.4 mm^2 mg^{-1} for *F. paniculata* , $t = 31.7$ and $P < 0.0001$).


Treatments
Time: years or season
Field vs. container
Irrigation vs. drought
Genotypes or cultivars
Light vs. shadow
N Nitrogen addition vs. no
T° Temperature
CO_2 CO_2 concentration
Specific leaf area (mm^2 mg^{-1})
0
20
40
60
80
Dactylis glomerata
Festuca paniculata
ITV DG
Interspecific variability
Overlap
ITV FP
N
T°
CO_2
Spring
Summer
Knevel et al. 2003
Volaire 2008
Sugiyama 2005
Sanderson et al. 2004
Garcez Neto et al. 2010
Belesky 2005
Harmens et al. 2000
Ryser et al. 2000
Roumet et al. 1999
Deckmyn et al. 1999
Al Haj Khaled et al. 2005
Albert et al. 2010a
Grassein et al. 2009
Albert et al. 2010a
Grassein et al. 2009
Knevel et al. 2003