Measuring functional diversity from multiple traits

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Functional diversity (FD)

- **Functional composition**: the value of species traits
- **Functional dispersion**: the spread, or variability, of species traits
- How to measure FD from **multiple traits**?

Sébastien Villéger et al 2008 Ecology August issue

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NEW MULTIDIMENSIONAL FUNCTIONAL DIVERSITY INDICES FOR A MULTIFACETED FRAMEWORK IN FUNCTIONAL ECOLOGY

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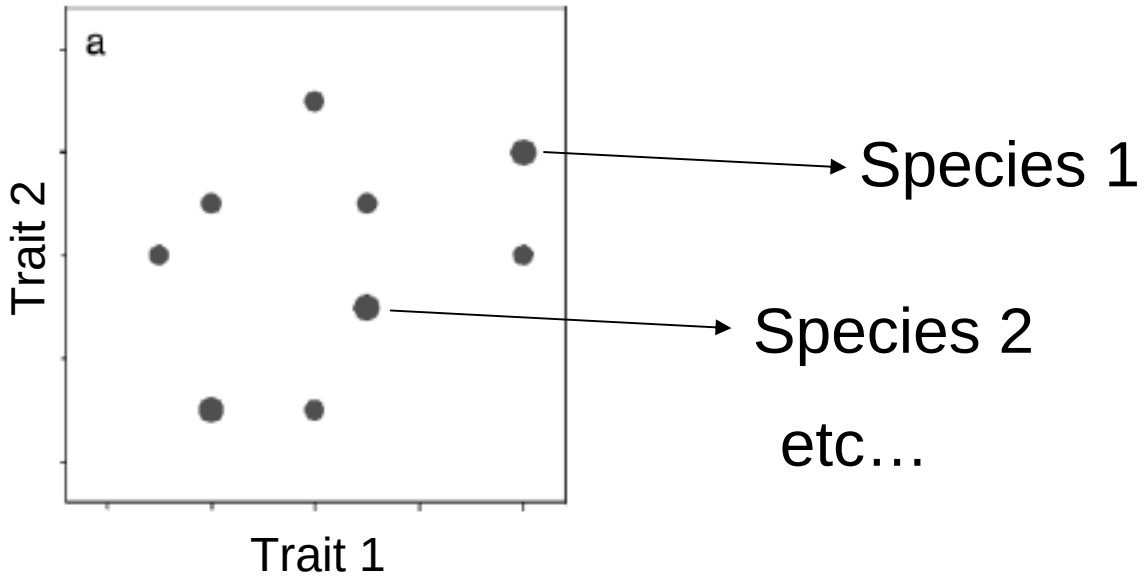
Abstract. Functional diversity is increasingly identified as an important driver of ecosystem functioning. Various indices have been proposed to measure the functional diversity of a community, but there is still no consensus on which are most suitable. Indeed, none of the existing indices meets all the criteria required for general use. The main criteria are that they must be designed to deal with several traits, take into account abundances, and measure all the facets of functional diversity. Here we propose three indices to quantify each facet of functional diversity for a community with species distributed in a multidimensional functional space: functional richness (volume of the functional space occupied by the

Functional trait space

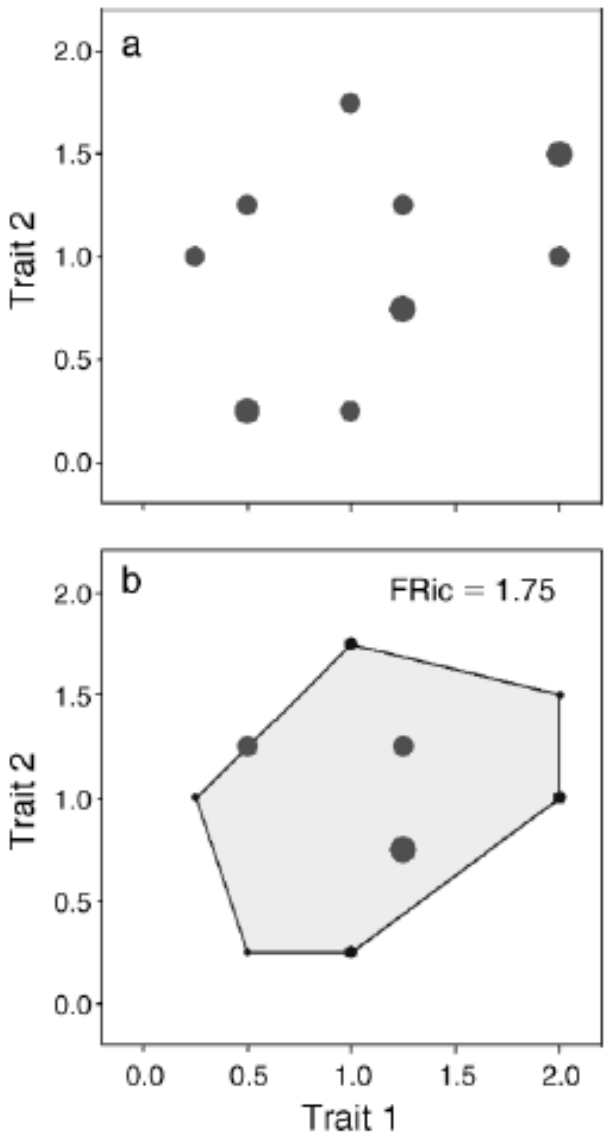


9 species in functional trait space (2 traits)

Size of black circle = relative abundance

Figure taken from Villéger et al 2008 Ecology

Functional richness
FRic



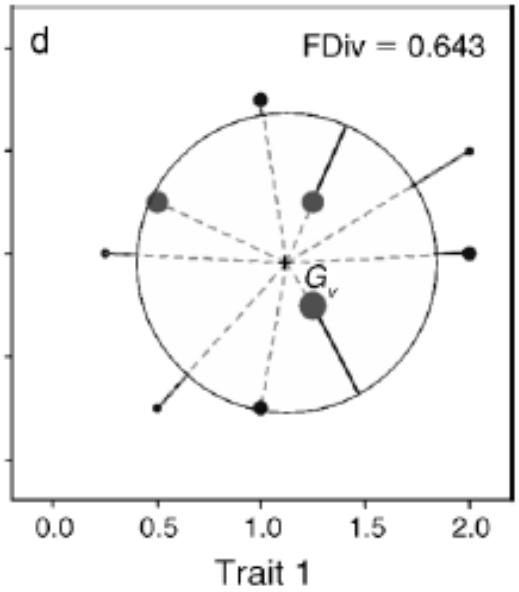
Functional richness (FRic):

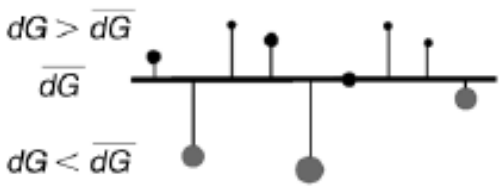
Volume of the minimum convex hull that includes all species

Amount of functional space filled by a community

Figure taken from Villéger et al 2008 Ecology

Functional divergence
FDiv





dG deviations from $\overline{dG}$

Functional divergence (FDiv):

The divergence of species from the center of gravity of the convex hull

$$\mathrm{FDiv} = \frac{\Delta d + \overline{dG}}{\Delta |d| + \overline{dG}}.$$

Figure taken from Villéger et al 2008 Ecology

Back to the basics

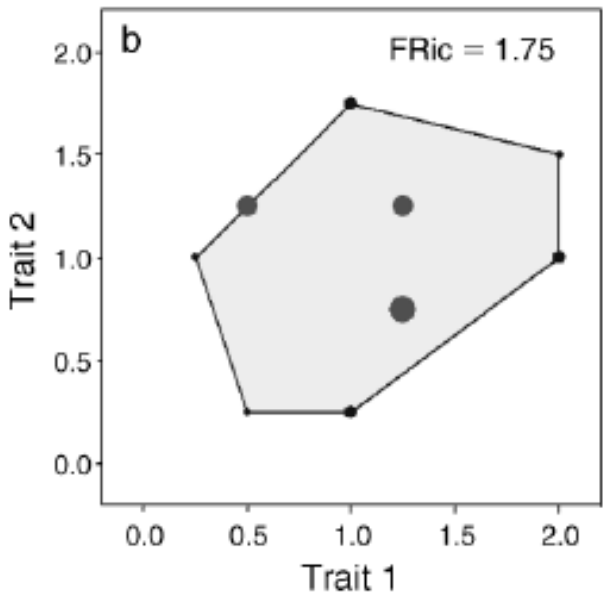
Functional dispersion:

… the **spread**, or **variability**, in the locations of the *S* species in the *T*-dimensional space

This concept is termed **dispersion** in statistics (e.g. SS, variance, SD, range, etc)

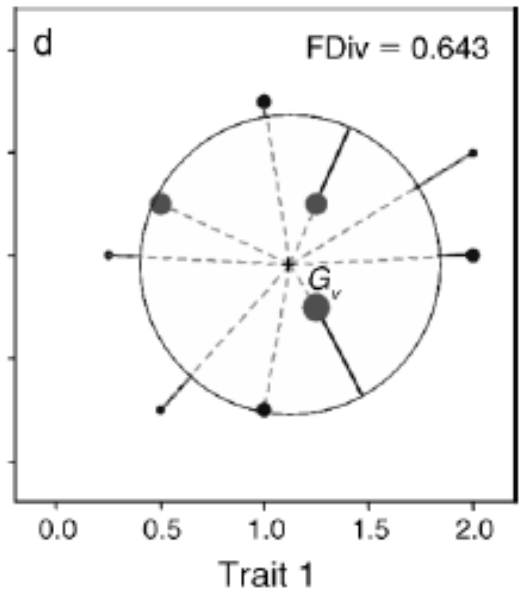
Problems with FRic and FDiv

FRic



- **Sensitive to outliers**
- **Strongly positively correlated with species richness**
- Does not consider abundances
- Need at least 3 species
- Need more species than traits

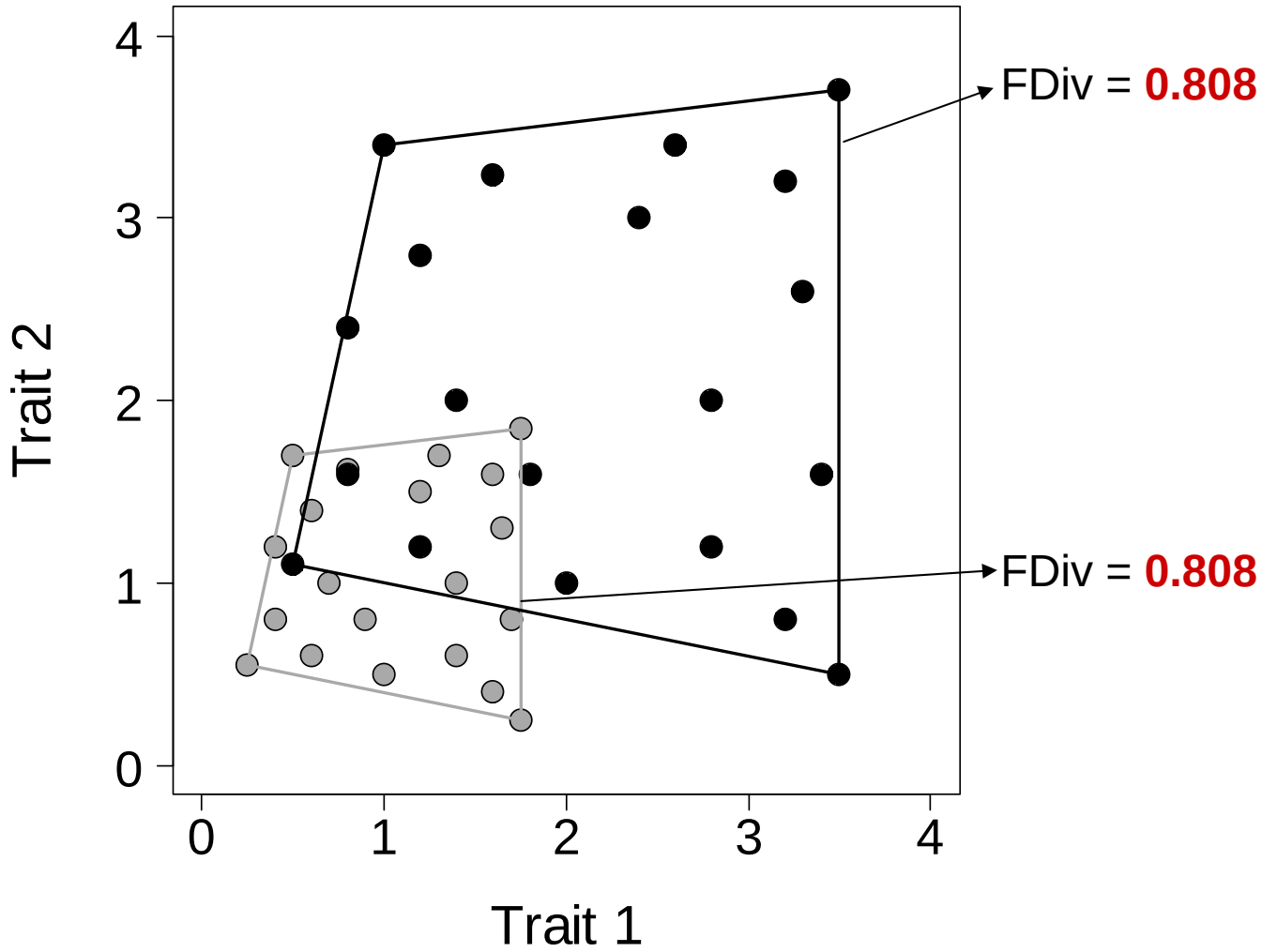
FDiv



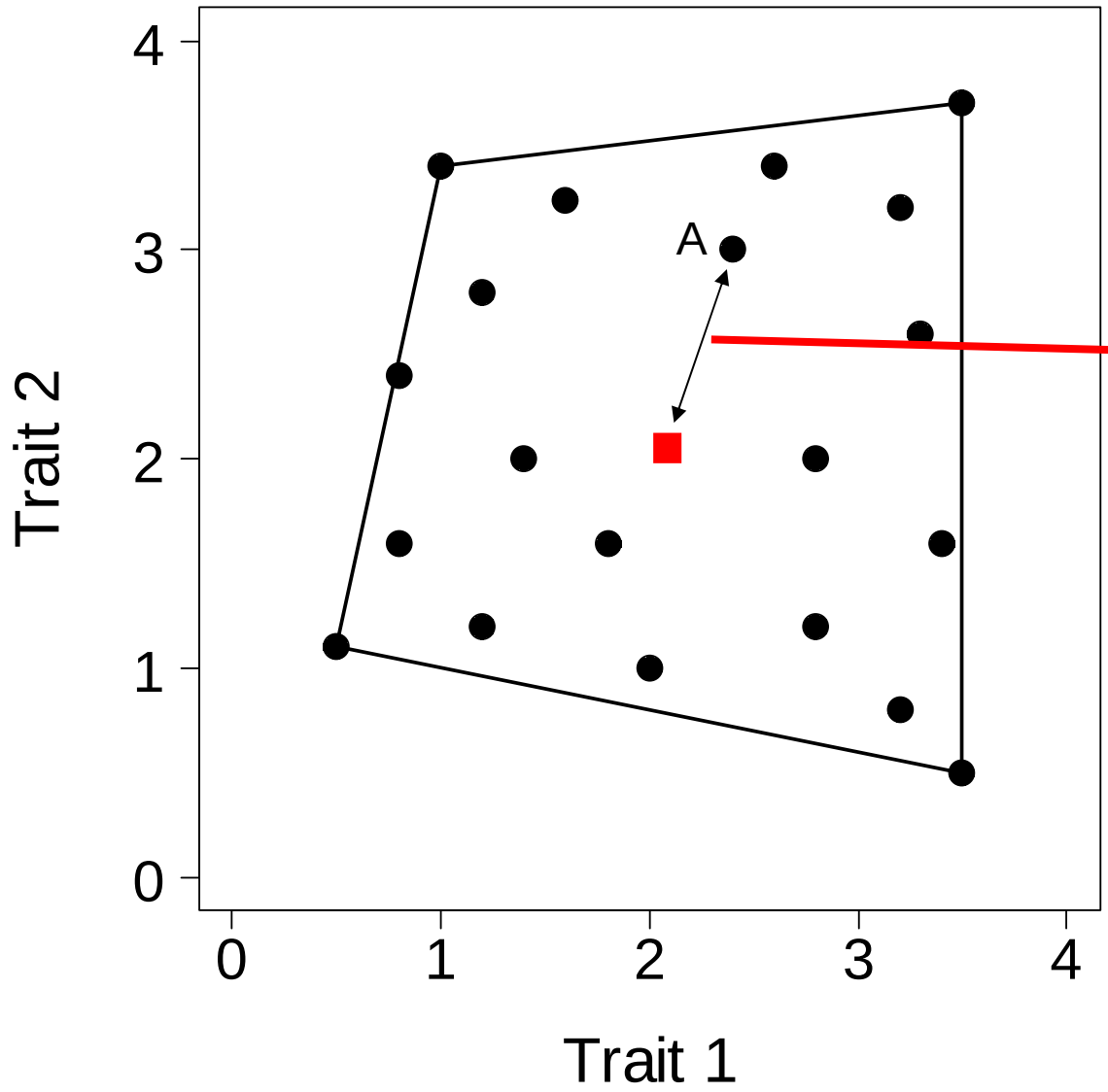
- **Sensitive to outliers**
- **Not sensitive to the size of the convex hull**
- Need more species than traits
- Need at least 3 species

Figures taken from Villéger et al 2008 Ecology

FDiv does not measure relative differences in functional dispersion



Functional dispersion (FDis)

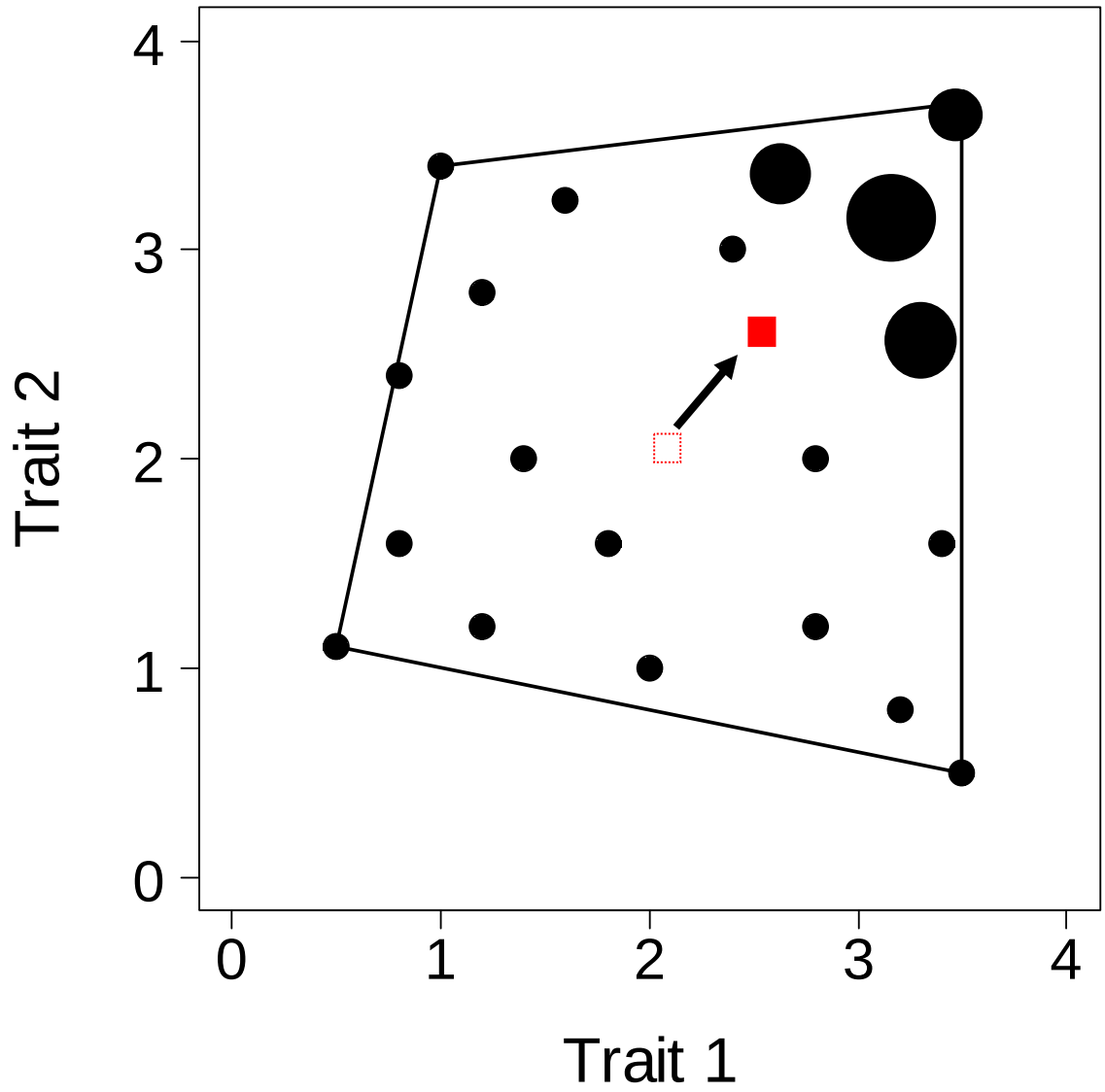


Distance of species A to group centroid

FDis = **average distance to centroid**

Laliberté and Legendre submitted

FDis and relative abundances

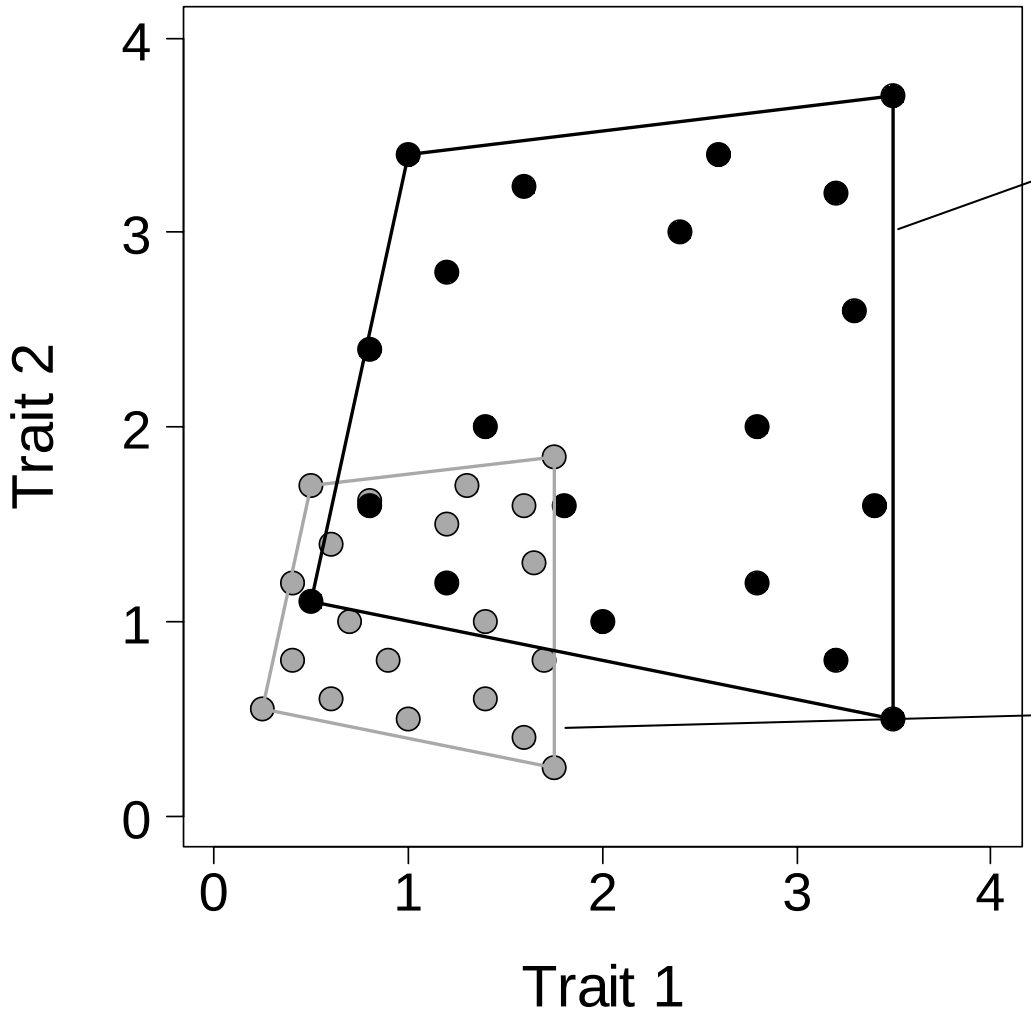


Centroid

Centroid shifts towards the more abundant species

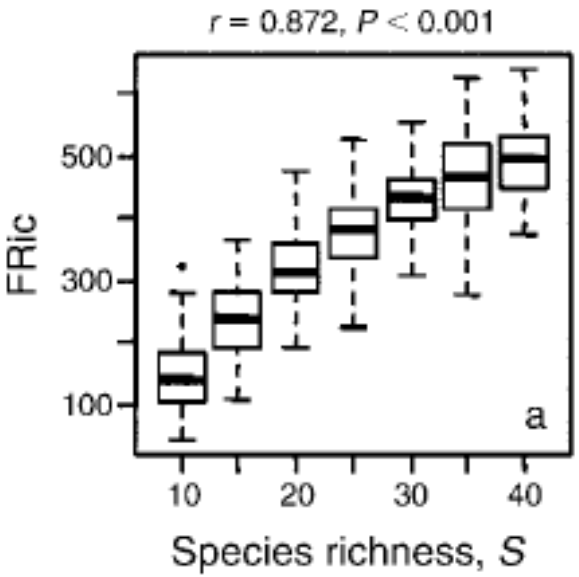
Laliberté and Legendre submitted

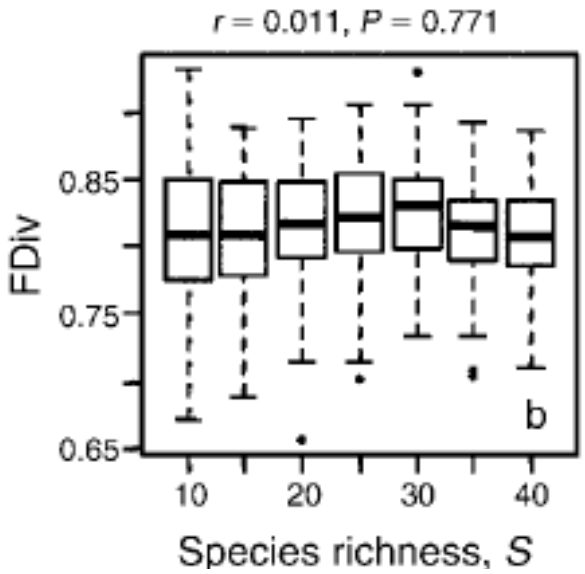
FDis measures relative differences in functional dispersion

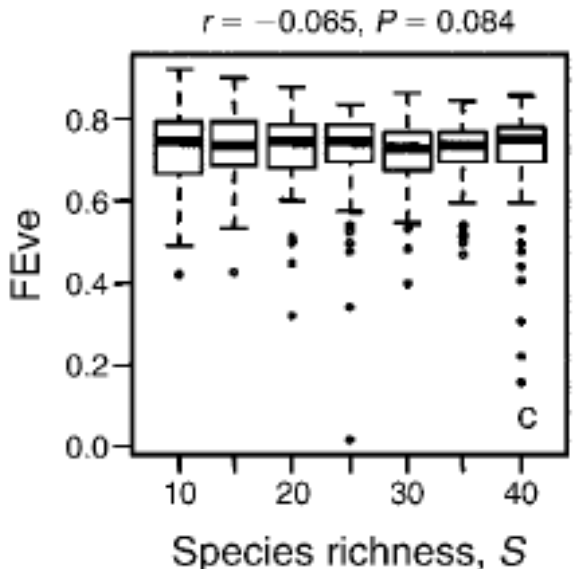


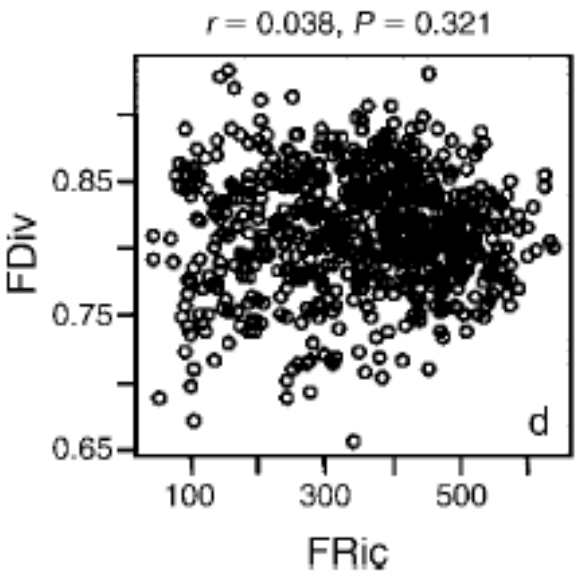
Laliberté and Legendre submitted

Simulations of Villéger et al





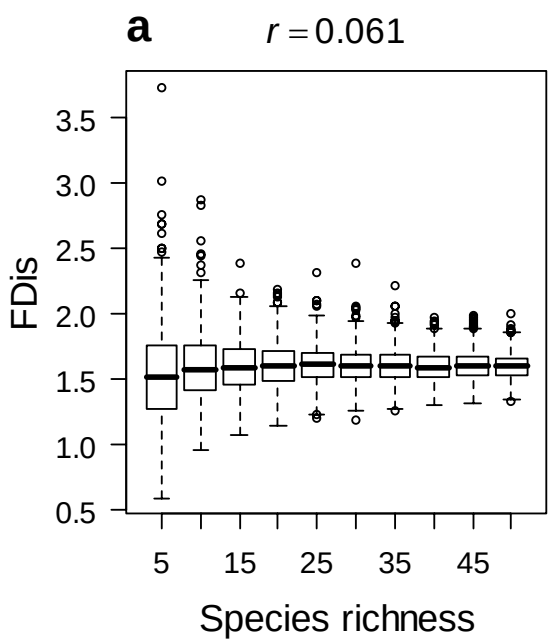


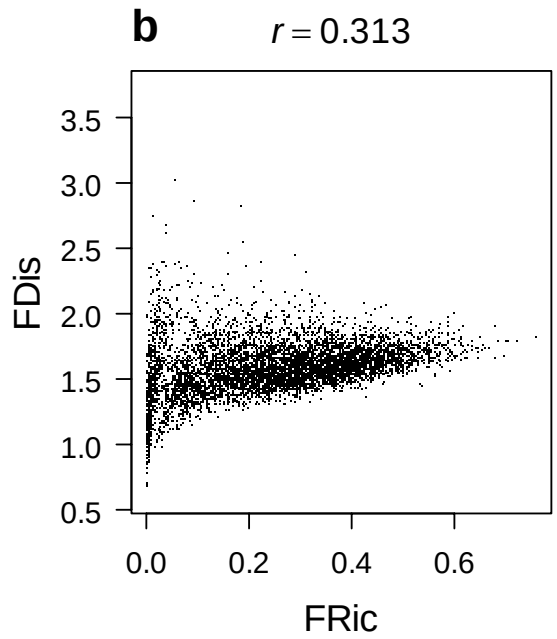


FRic is positively related to species richness

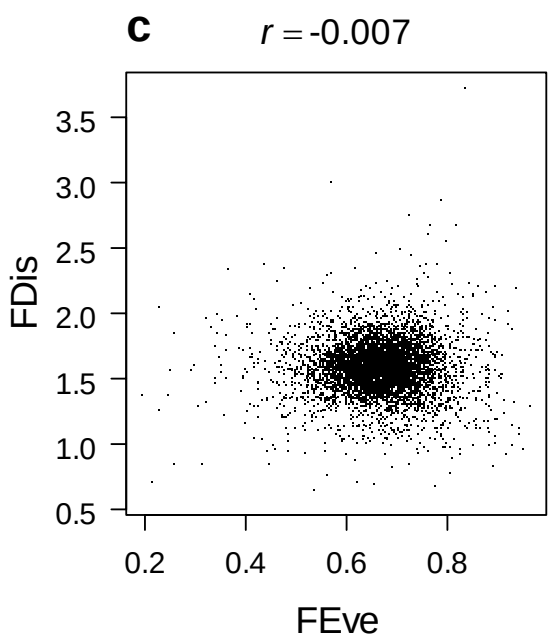
Figure taken from Villéger et al 2008 Ecology

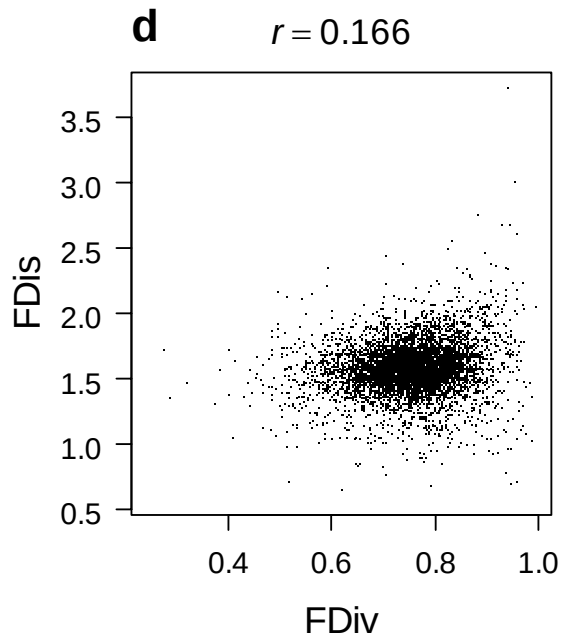
FDis is not influenced by species richness





Positively related to FRic and to a lesser degree FDiv





Laliberté and Legendre submitted

Desirable properties of FDis

1) Intuitive
2) Can use multiple traits (any number or type)
3) Less sensitive to outliers
4) Direct comparison of functional dispersion
5) Min. 2 species (3 for FRic and FDiv)
6) Independent of species richness
7) Can integrate relative abundances

dbFD: R function to measure FD

- www.elaliberte.info
- Any type of traits (continuous, categorical, ordinal)
- Tolerates missing trait values
- 3 indices of Villéger et al, plus FDis
- Community-weighted trait means (CWM): functional composition
- Functional group richness (FGri)

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Talk at ESA

ARC-NZ Research Network for
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Working Group 31, 11 February 2008
Human-influenced countrysides and plant traits

Back: Dan Metcalfe, Stephen Bonser, Peter Vesk, John Morgan, Fabrice De Clerk, Etienne Laliberte, Margie Mayfield
Front: Jessie Wells, Carla Catterall, Cibele Queiroz

Global patterns of plant response diversity with land use intensification

Thursday, after morning tea