

MAR estimates¹

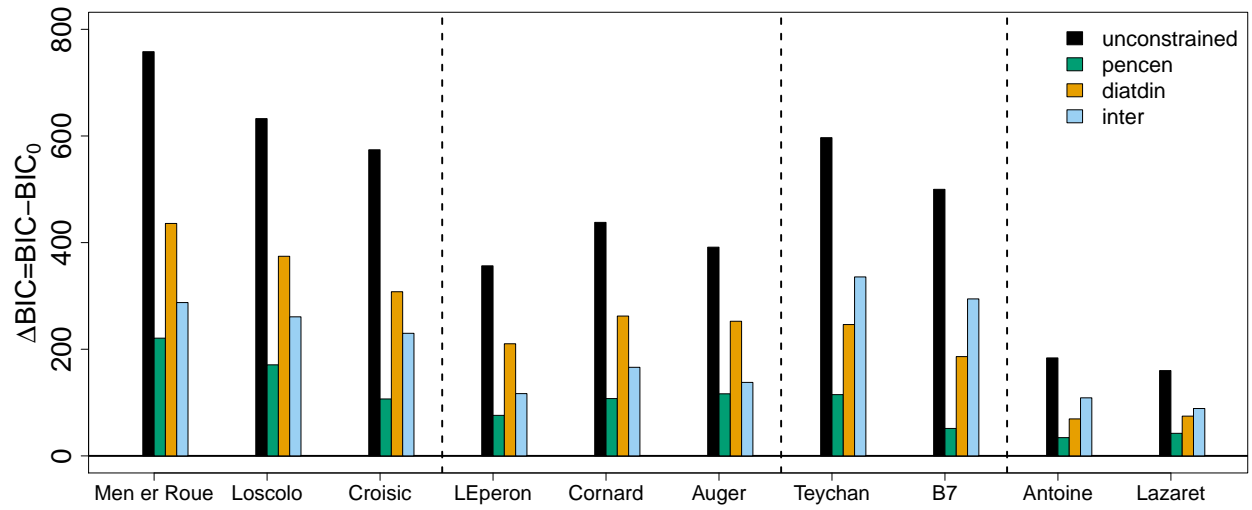


Figure 1: Comparison of BIC with different interaction matrices, compared to the null model (diagonal interaction matrix), for four different sites separated by dashed lines (Brittany, Marennes-Oléron, Arcachon Mediterranean Sea) and 10 different subsites. As model structures (length of the times series taken into account) are different between sites and subsites, groups of bars should not be compared.

¹We should note that NEE does not like barplot...

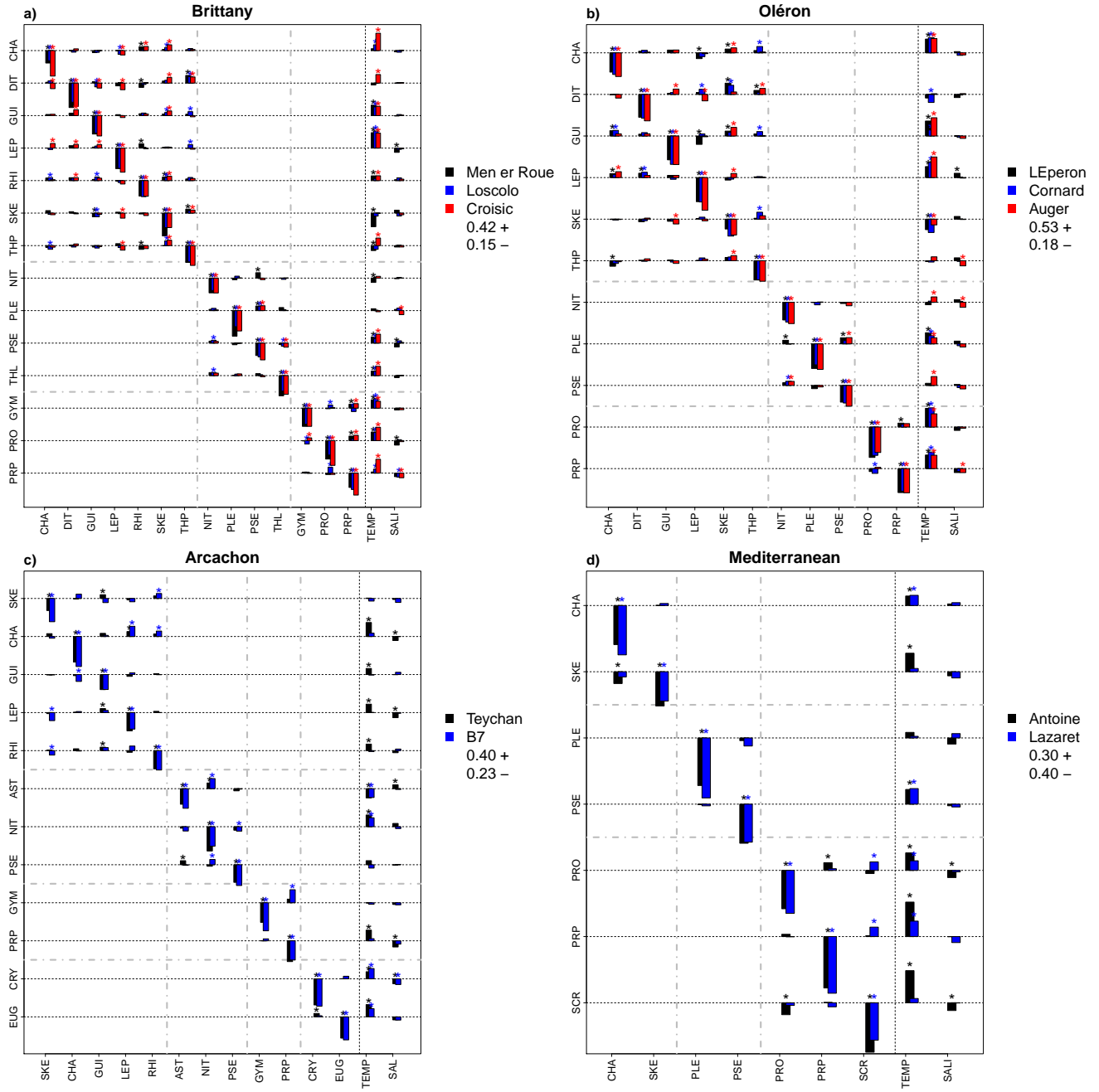


Figure 2: Coefficients of the pennate vs. centric MAR model for species which are present at the 10 sampling subsites, using temperature and salinity as covariates. The ratio of positive and negative interactions which have the same signs for all subsites in one site (not considering diagonal values, that is intragroup interactions) is shown below each legend.

Matrix analysis

Hereafter, we consider the 10 interaction matrices (**B-I**) estimated in the different subsites as 10 repetitions of possible community matrices. Both the unconstrained (full) and the pennate/centric matrices are analyzed, with a focus on the latter, which yields the lower BIC (analyses for the unconstrained matrix can be found in the graph folder). In both cases, all coefficients are taken into account (as opposed to the significant ones only). For unconstrained matrices, there are between 21% and 39% of significant coefficients, while for pence matrices, they represent between 35% and 59% of estimated interactions (13% to 21% of all interactions). We characterize the interaction matrices with usual quantitative metrics and search for patterns in the strength of the coefficients.

Usual network metrics

Local stability A first proxy of the local stability of the community can be found in the eigenvalues of the interaction matrix. We present the maximum modulus of the eigenvalues of each matrix in Table 1 and compare them to the proportion of strictly positive interactions in Fig. 3. No clear relation can be found in the unconstrained matrices but there seems to be a decreasing trend with the increase in the proportion of positive interactions.

	Unconstrained (eig)	% positive	Pennate/centric (eig)	% positive
Men er Roue	0.57	57	0.52	57
Loscolo	0.53	56	0.42	50
Croisic	0.65	52	0.50	49
L'Eperon	0.58	59	0.44	53
Cornard	0.49	51	0.46	47
Auger	0.57	55	0.51	55
Teychan	0.59	55	0.46	45
B7	0.64	50	0.57	38
Antoine	0.55	47	0.55	30
Lazaret	0.64	37	0.61	24

Table 1: Maximum modulus of the interaction matrix eigenvalues and proportion of strictly positive interactions in the interaction matrices estimated in different sites, with a full matrix or a matrix only allowing interactions within pennate and centric diatom groups, not between them.

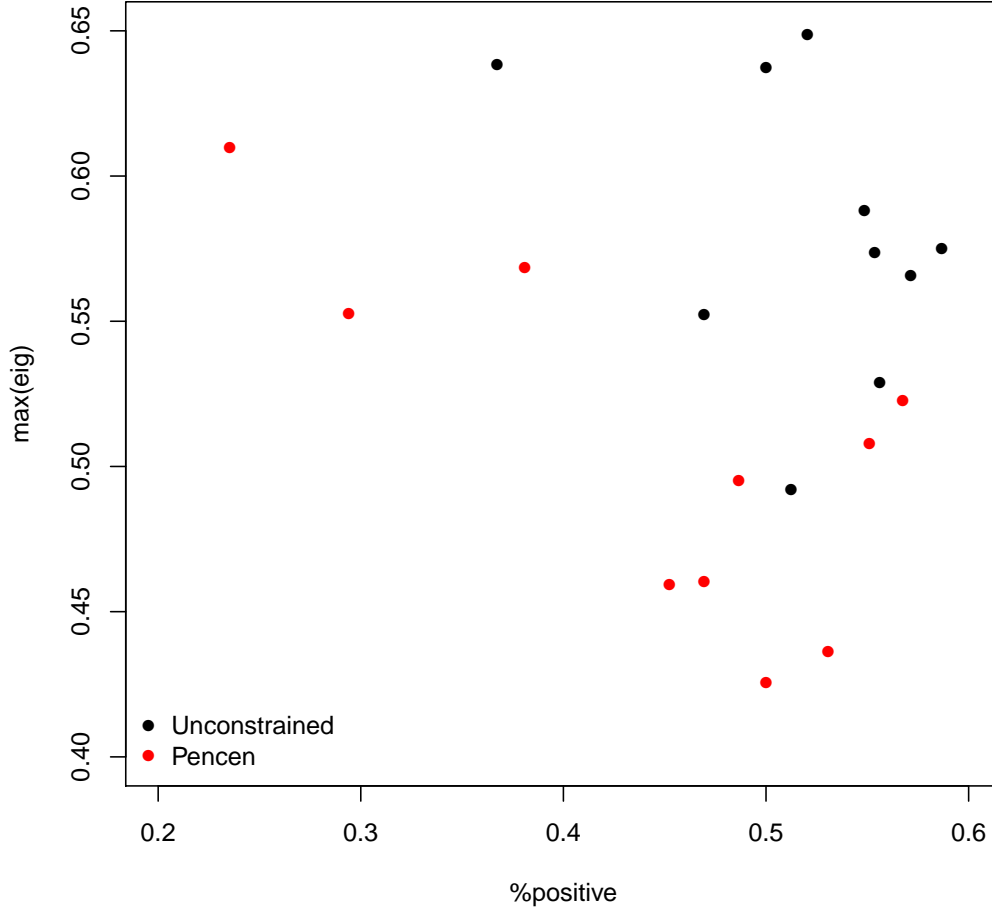


Figure 3: Maximum modulus of the interaction matrix eigenvalues as a function of their proportion of strictly positive interactions. Unconstrained (full) and pennate/centric matrices are shown in black and red, respectively.

Link properties The usual definition of connectance does not fit our case as we take the same number of links into account in the unconstrained ($C=1$) and the pencen matrix ($0.29 < C < 0.41$, depending on the site but stable among subsites). However, weighted connectance and weighted linkage density [Bersier et al., 2002, van Altena et al., 2016] use the information about the strength of the interactions in the matrices.

These quantitative metrics were developed for bipartite or trophic only matrices, in which interactions all bear the same sign and represent the same phenomenon (competition or feeding rate, for example). They only apply to positive values of coefficients. Our matrices include apparent mutualism (+/+, between 19% and 35% of estimated interactions in the pencen matrix, with the notable exception of Lazaret where no such interaction can be found), facilitation-commensalism (+/-, 12-57%) and antagonism (-/-, 22-65%) according to Stachowicz [2001]’s classification. We thus decided to compute the same metrics on either the absolute values of all interactions, only the positive and only the negative values of each matrix.

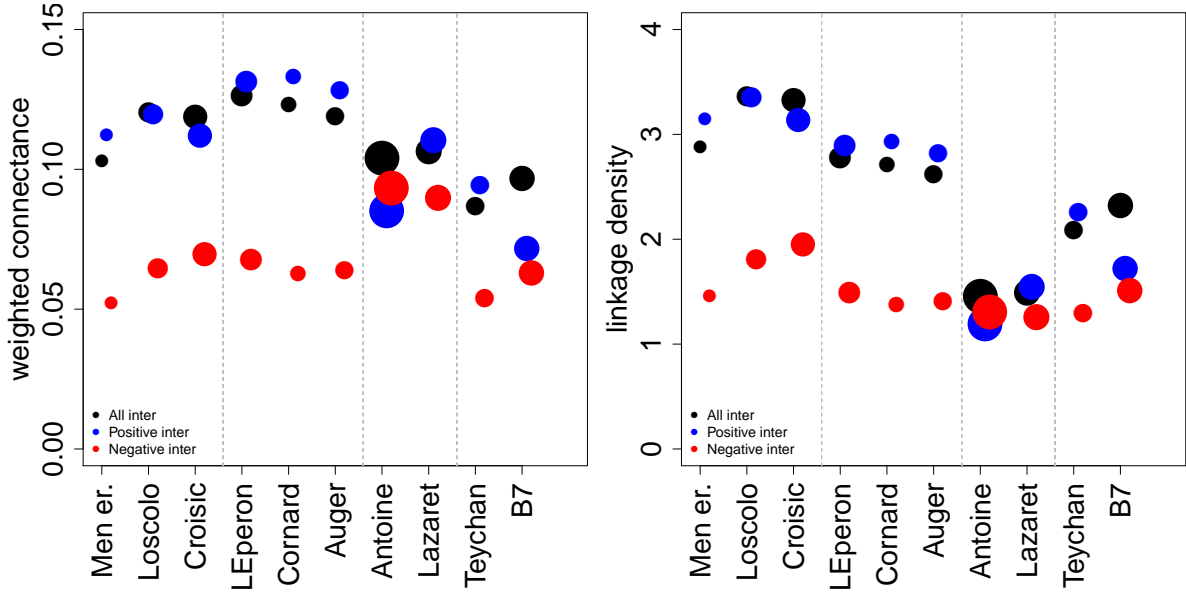


Figure 4: Weighted connectance and linkage density of the pennate/centric interaction matrices estimated in 10 different subsites, differentiating between absolute values of all interactions (black), positive (red) and negative (blue) interactions. Dot sizes increase with the proportion of coefficients that are deemed significant at the 5% threshold.

If we consider only the strength of the interactions (absolute values of the coefficients), weighted connectance does not vary much from one site to another (Fig. 4). Positive interactions tend to dominate in all matrices, except for the Mediterranean ones in which both negative and positive interactions seem to play equivalent roles. We should keep in mind that they also correspond to the smallest communities (7 species monitored consistently, as opposed to 14 in the Brittany sites).

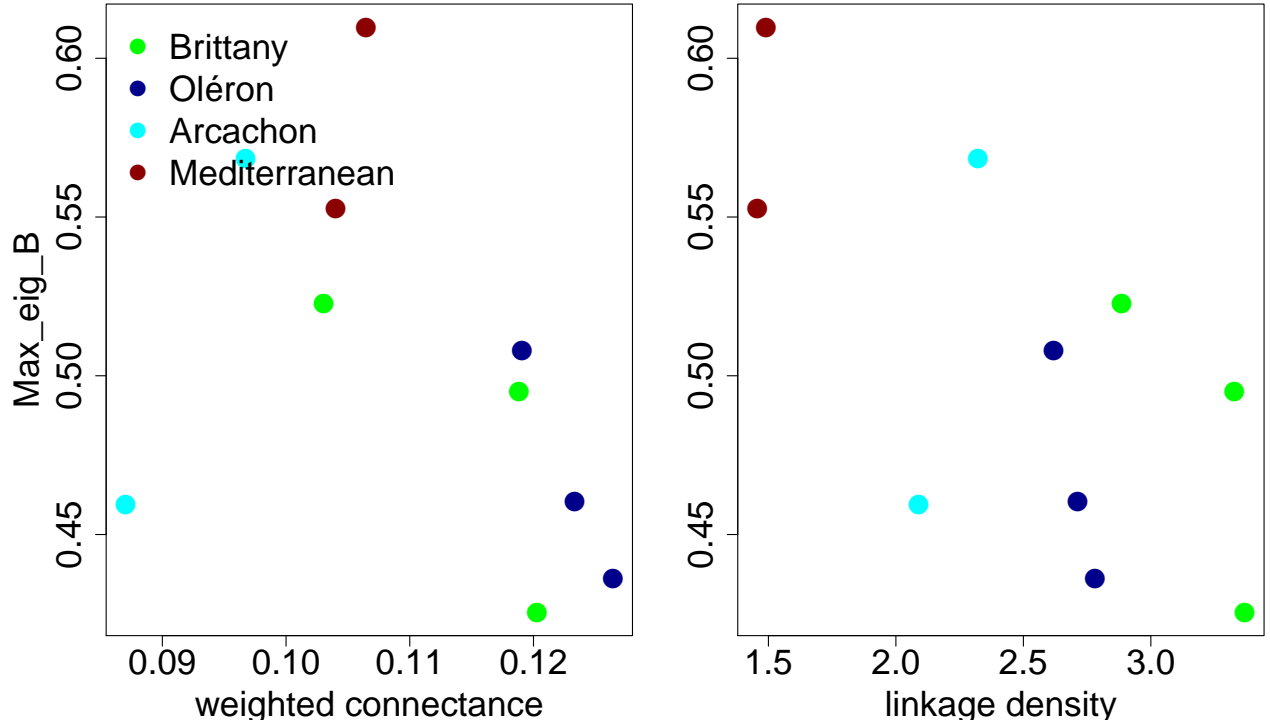


Figure 5: Maximum modulus of the interaction matrix eigenvalues as a function of weighted connectance and linkage density in pennate/centric matrices in 10 different subsites.

In Fig. 5, stability seems to decrease with weighted connectance and linkage density, as opposed to previous work using the same metrics [van Altena et al., 2016].

Covariance between self-regulation and competition with other groups

The differences between self-regulation and inter-genus competition appears in the **B-I** matrices, informing both the ecology of the groups of species we consider (variation in self-regulation can be seen in Fig. 6) and the functioning the whole communities. For the latter, we sought patterns in the variation of intra- and inter-group interaction coefficients.

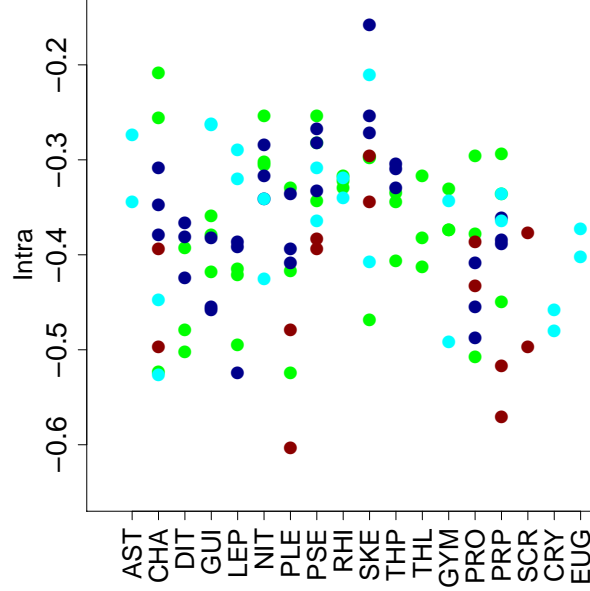


Figure 6: Self-regulation (values of the diagonal coefficients of the **B-I** matrices) for each genus in 10 sites for a pennate/centric interaction matrix.

Intra and inter-group coefficients have different means and variances (Fig. 7), and we could not find the U-shaped curve that was found by Jansen and Kokkoris [2003].

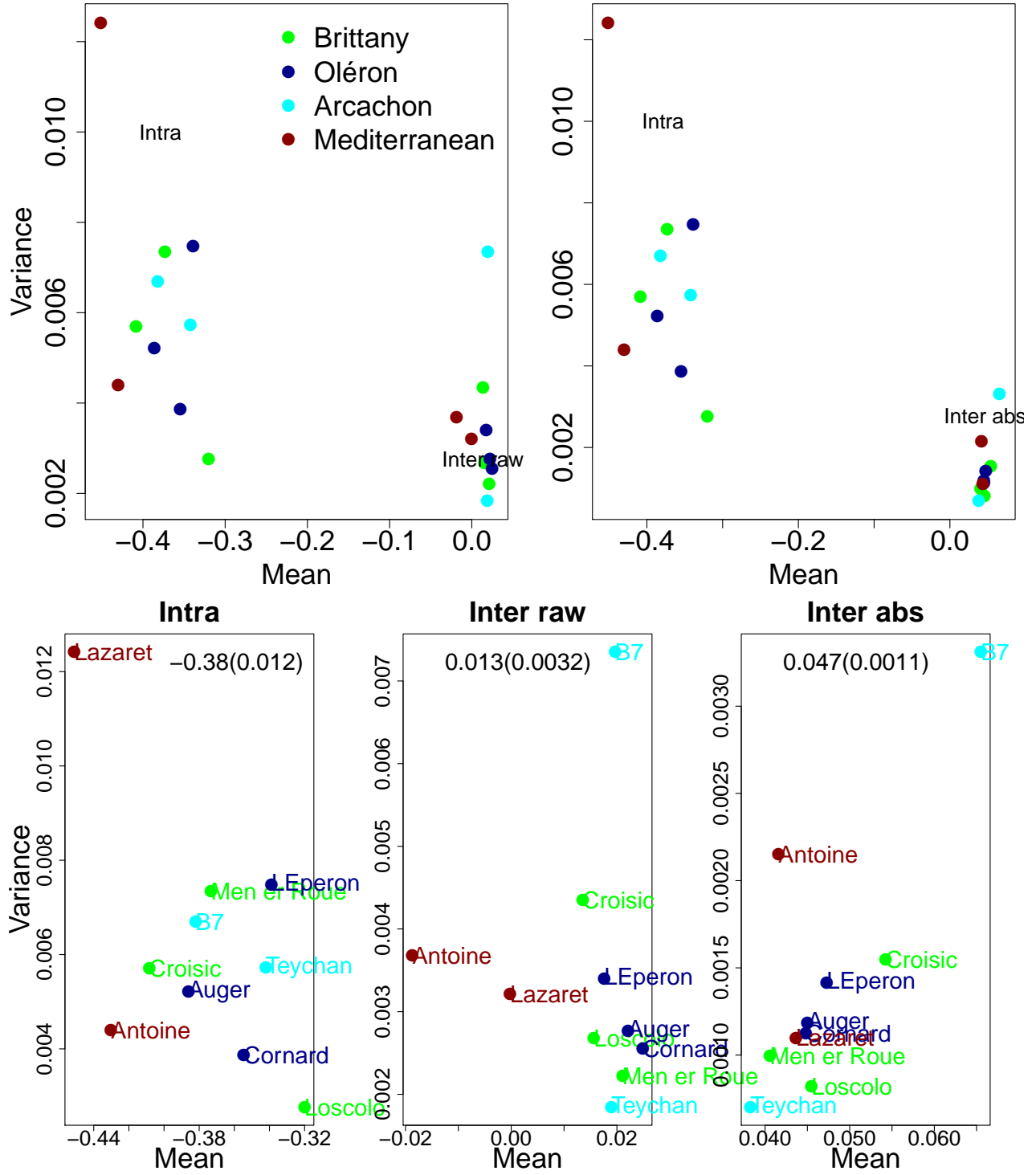


Figure 7: Variance of intra (left-hand side of each plot) and intergroup (right-hand side of each plot) coefficients of the **B-I** matrices, as a function of their mean, ignoring the forced 0 coefficients. A zoom-in is performed in the bottom line of the figure, with mean (and variance) written on the plot.

To examine a possible covariation of intra and inter-genus competition, we computed several indicators of intergroup competition. For each genus i , an index of vulnerability (using all b_i coefficients, that is the i^{th} row, excluding diagonal coefficients) and generality (using all b_i coefficients, that is the i^{th} column, excluding diagonal coefficients) can be computed. For these two indices, we computed the average of raw and absolute values of the interaction coefficients and the Pearson correlation with the value of intragroup coefficients. No obvious relation can be found

(Fig. 8).

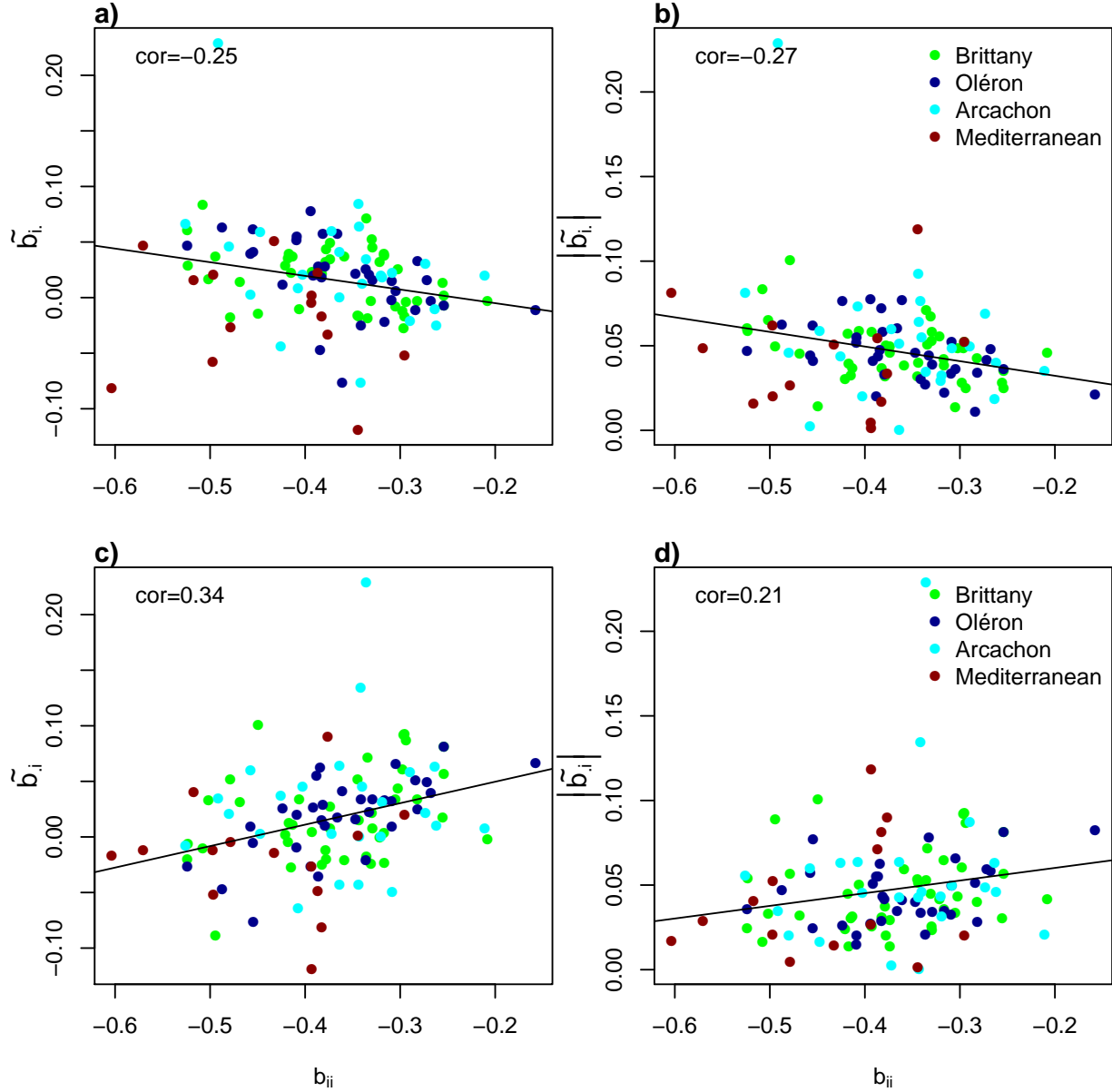


Figure 8: Average vulnerability (a-b) and generality (c-d), computed on raw values (a-c) or absolute values (b-d), as a function of self-regulation, for a pennate-centric interaction matrix, ignoring the forced 0 coefficients.

Contrary to what could be found in Kokkoris et al. [2002], we could not detect a decreasing trend in stability due to the increase in variance in the interaction coefficients (Fig. 9).

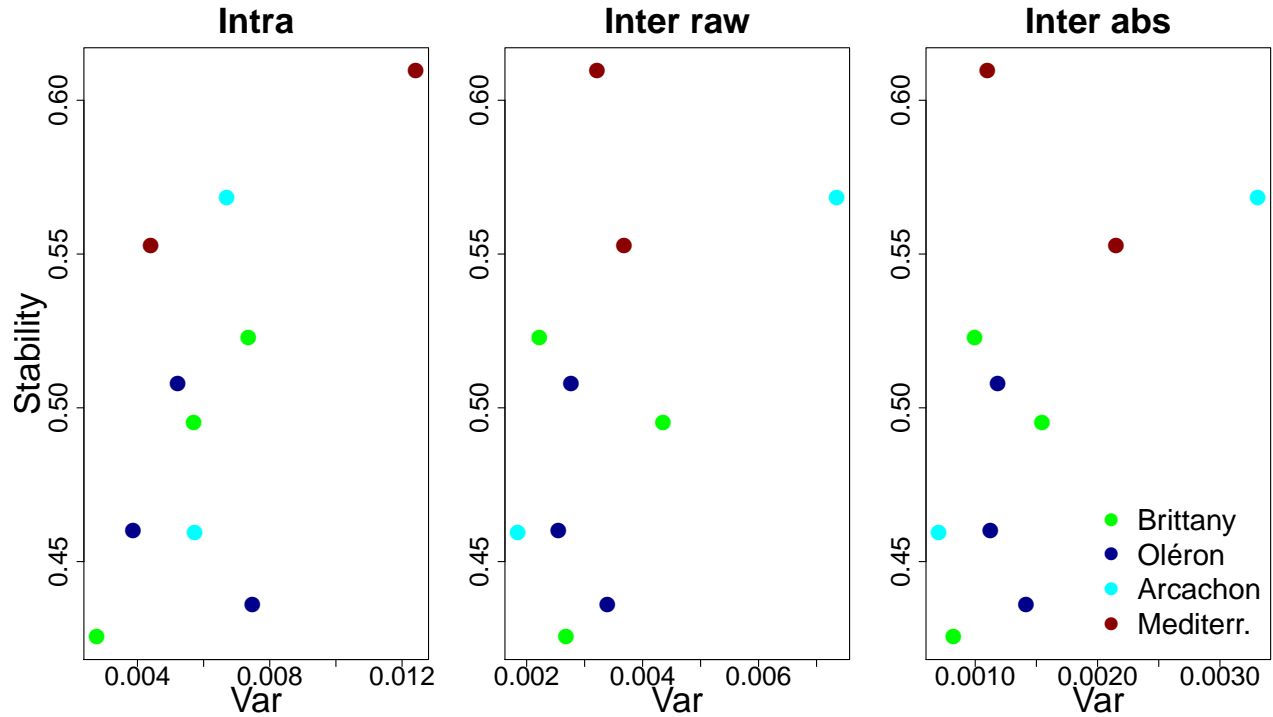


Figure 9: Maximum modulus of the eigenvalues of $\mathbf{B-I}$ matrices, as a function of the variance of their coefficients, for pennate/centric interaction matrices, ignoring the forced 0 coefficients

Discussed, to do ?

Finally, we also wanted to consider the variance between growth rate and intragroup competition (b_{ii} vs. \bar{c}_i , or only consider eigenvalues? Would it make sense?)

In addition to averaging, we can consider the standard deviation of intergroup coefficients and environmental effects.

References

- Louis-Felix Bersier, Carolin Banašek-Richter, and Marie-France Cattin. Quantitative descriptors of food-web matrices. *Ecology*, 83(9):2394–2407, 2002.
- Vincent A. A. Jansen and Giorgos D. Kokkoris. Complexity and stability revisited. *Ecology Letters*, 6(6):498–502, June 2003. ISSN 1461-023X, 1461-0248. doi: 10.1046/j.1461-0248.2003.00464.x.
- Giorgos D. Kokkoris, Vincent A. A. Jansen, Michel Loreau, and Andreas Y. Troumbis. Variability in interaction strength and implications for biodiversity. *Journal of Animal Ecology*, 71(2):362–371, March 2002. ISSN 0021-8790, 1365-2656. doi: 10.1046/j.1365-2656.2002.00604.x.
- John J. Stachowicz. Mutualism, Facilitation, and the Structure of Ecological Communities. *BioScience*, 51(3):235, 2001. ISSN 0006-3568. doi: 10.1641/0006-3568(2001)051[0235:MFATSO]2.0.CO;2.
- Cassandra van Altena, Lia Hemerik, and Peter C. de Ruiter. Food web stability and weighted connectance: the complexity-stability debate revisited. *Theoretical Ecology*, 9(1):49–58, February 2016. ISSN 1874-1738, 1874-1746. doi: 10.1007/s12080-015-0291-7.