fdcoexist

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This document presents the relationships between functional traits of species and an environmental gradient.

Our coexistence model is developed following this equation:

$$N_{t+1,i,x} = \frac{R_{i,x} \times N_{t,i,x}}{1 + A \times \alpha_i} \tag{1}$$

with

$$\alpha_i = \sum_{j=1, j \neq i}^{S} N_{t,j,x} \times (1 - \delta_{ij}) \tag{2}$$

$$R_{i,x} = k \times \exp\left(-\frac{(\text{trait}_i - \text{env}_x)^2}{2 \times \text{width}^2}\right) \tag{3}$$

If we replace α_i and $R_{i,x}$ in the first equation it gives:

$$N_{t+1,i,x} = \frac{k \times \exp\left(-\frac{(\text{trait}_i - \text{env}_x)^2}{2 \times \text{width}^2}\right) \times N_{t,i,x}}{1 + A \times \sum_{j=1, j \neq i}^{S} N_{t,j,x} \times (1 - \delta_{ij})} \tag{4}$$

The equation above only considers inter-specific competition when $j \neq i$ in the sum. We can however add intra-specific competition when $j = i$. Each site has a species-specific carrying capacity K as the number of individuals approaches this carrying capacity the intra-specific competition increases:

$$\alpha_{ii} = B \times N_{t,i,x} \tag{5}$$

Thus the equation becomes:

$$N_{t+1,i,x} = \frac{k \times \exp\left(-\frac{(\text{trait}_i - \text{env}_x)^2}{2 \times \text{width}^2}\right) \times N_{t,i,x}}{1 + A \times \sum_{j=1,\ j \neq i}^{S} N_{t,j,x}(1 - \delta_{ij}) + B \times N_{t,i,x}} \tag{6}$$

with A the coefficient scaling inter-specific competition and B the one for intra-specific competition.

Because several traits participate to the growth term depending on their contribution we can rewrite the growth term as:

$$R_{i,x} = \sum_{g=1}^{T} w_g \times k \times \exp\left(-\frac{(\text{trait}_{g,i} - \text{env}_x)^2}{2 \times \text{width}^2}\right) \tag{7}$$

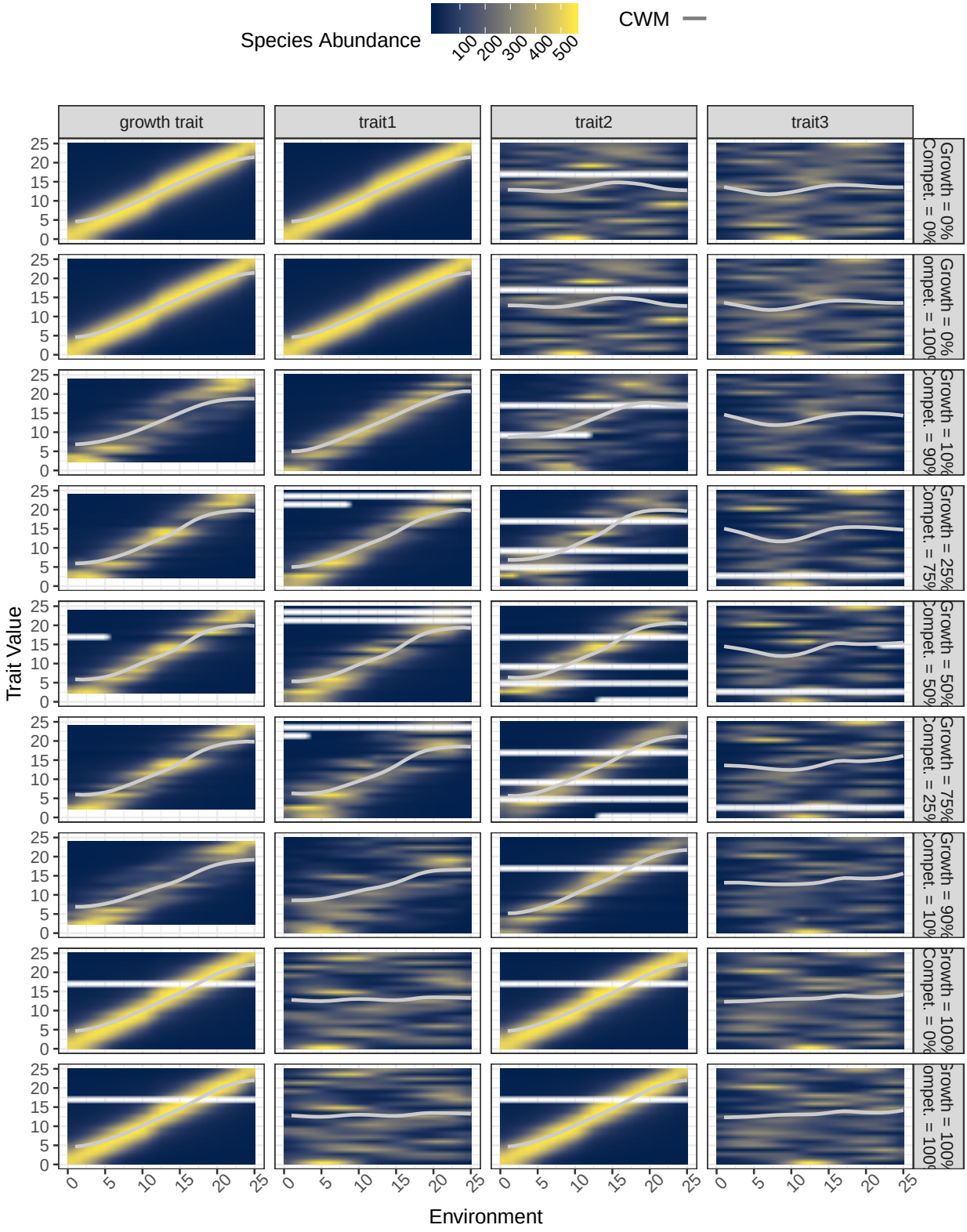
with g the trait number, $0 \leq w_g \leq 1$ the contribution of this trait to growth (and $\sum_{g=1}^{T} w_g = 1$), $\text{trait}_{g,i}$ the trait number g of species i.

Constant environmental filtering strength

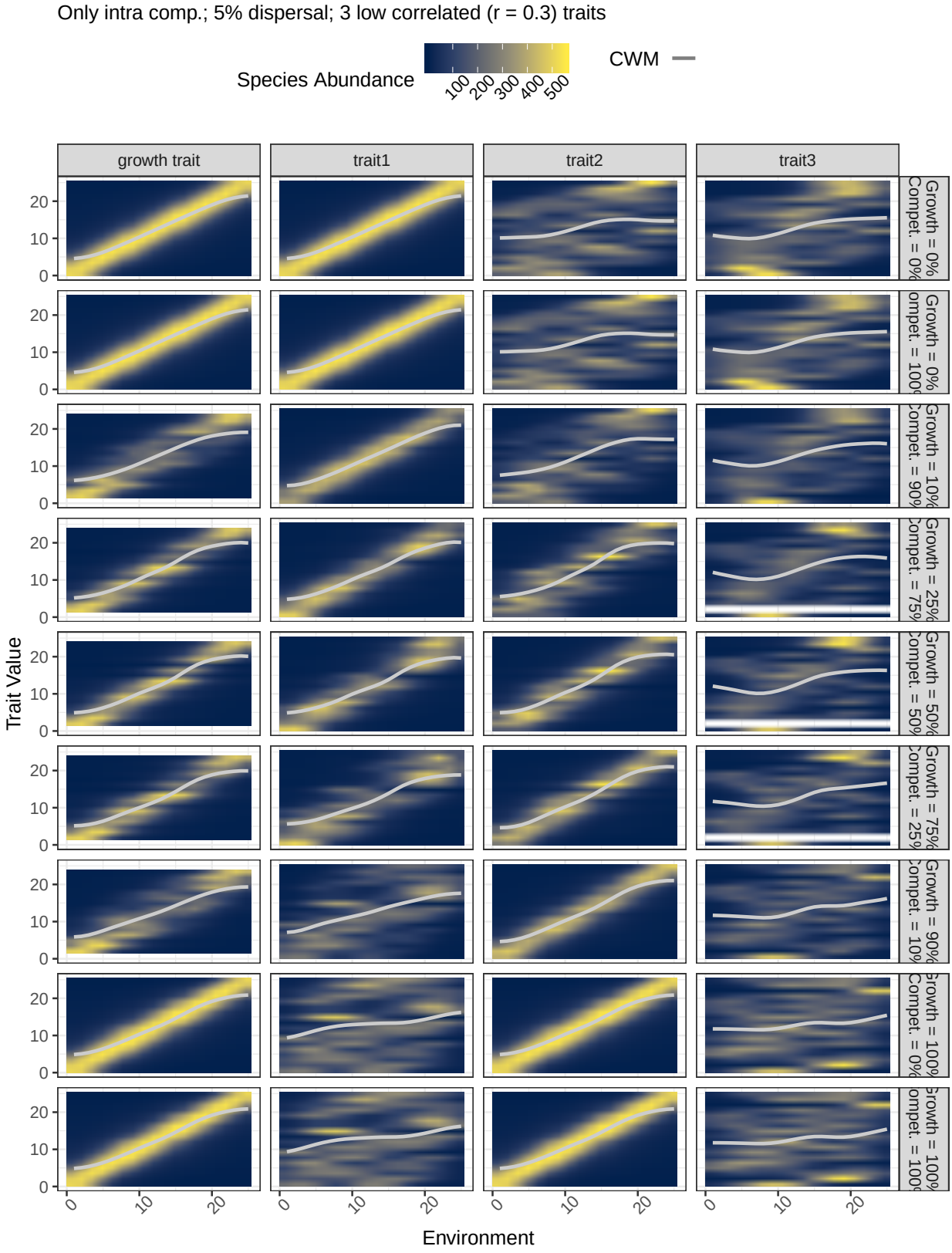
Without Competition (only intra-specific competition)

We can run the simulations without any competition `A = 0` to see if we see the theoretical patterns.

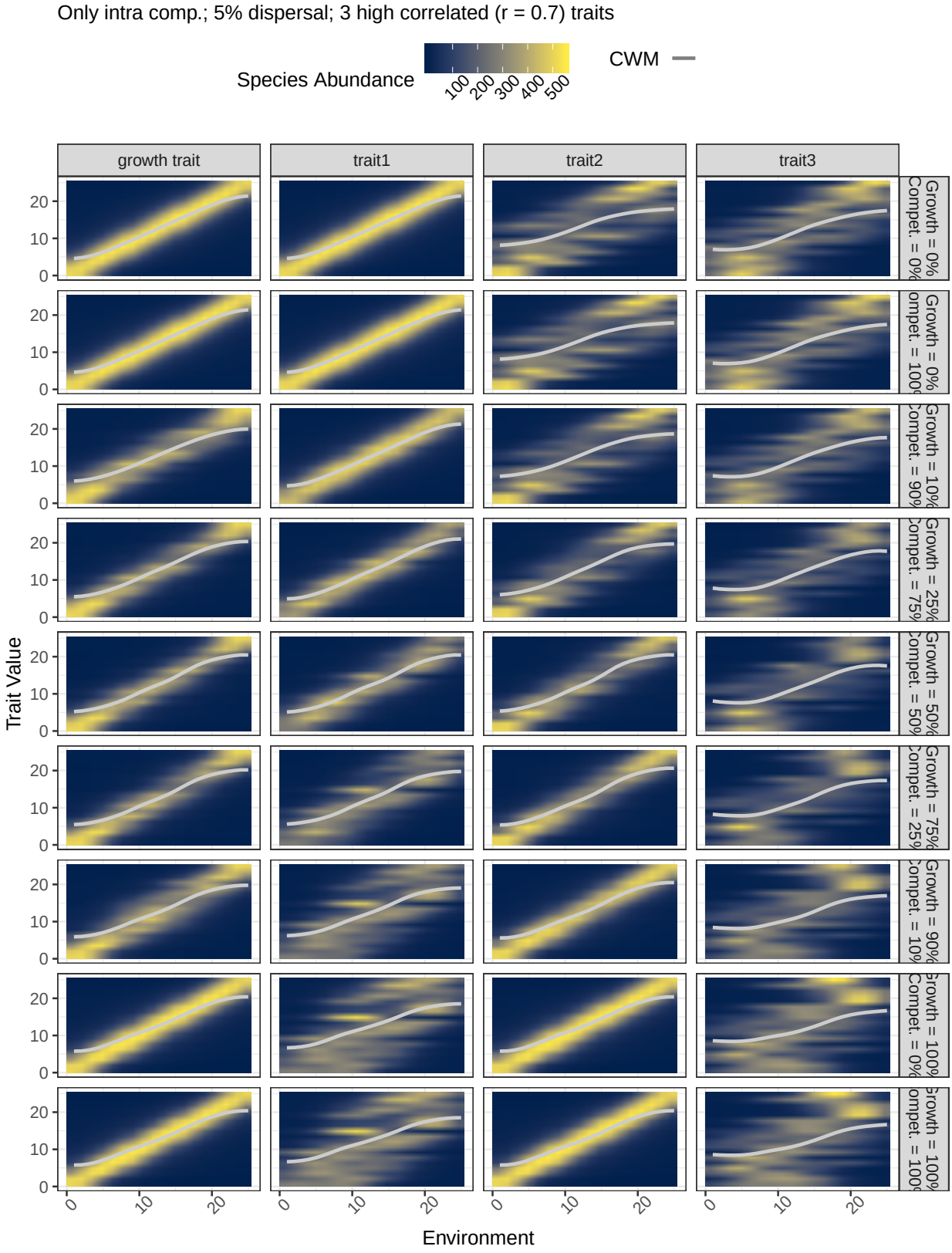
No correlations among traits



Low correlations among traits

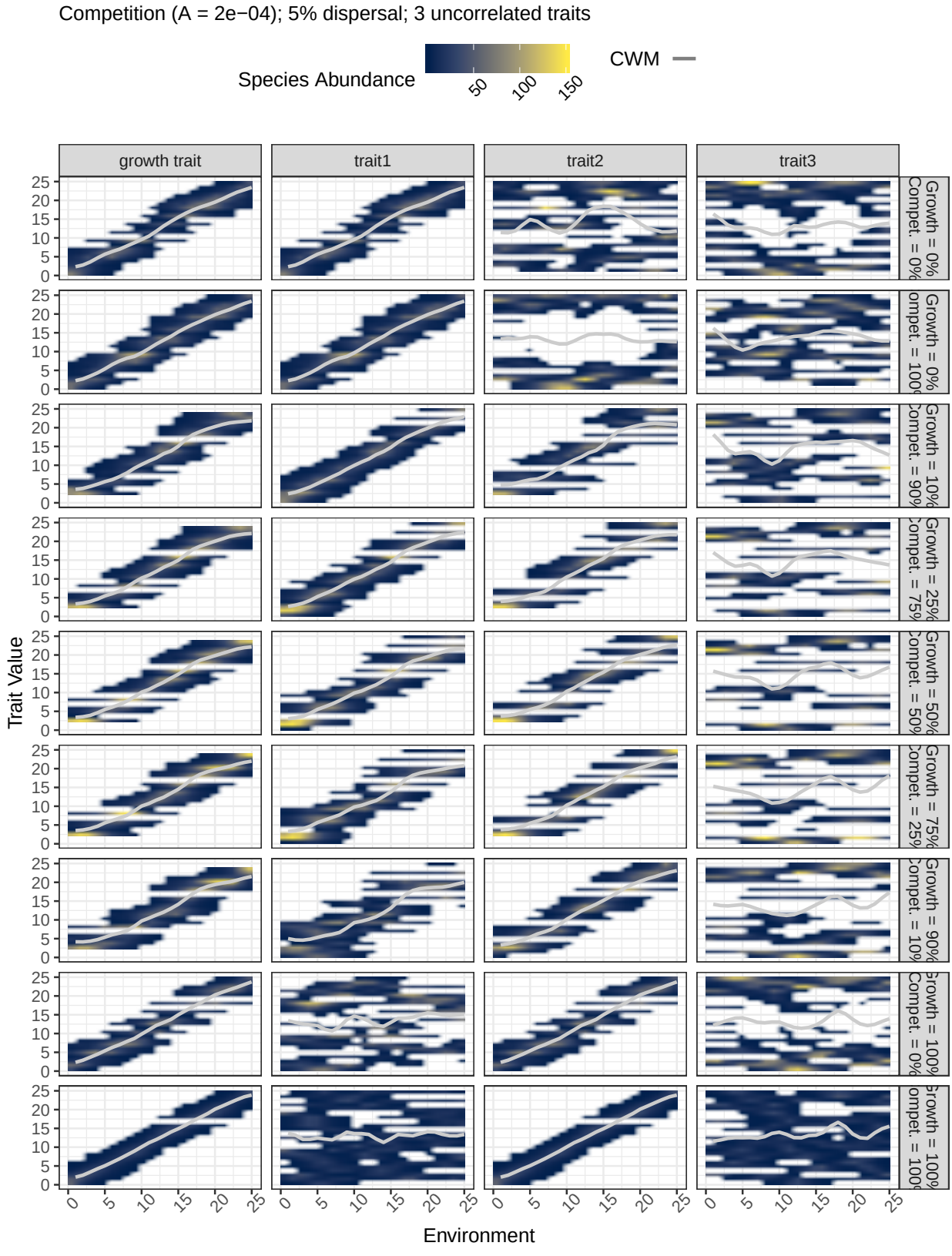


High correlations among traits

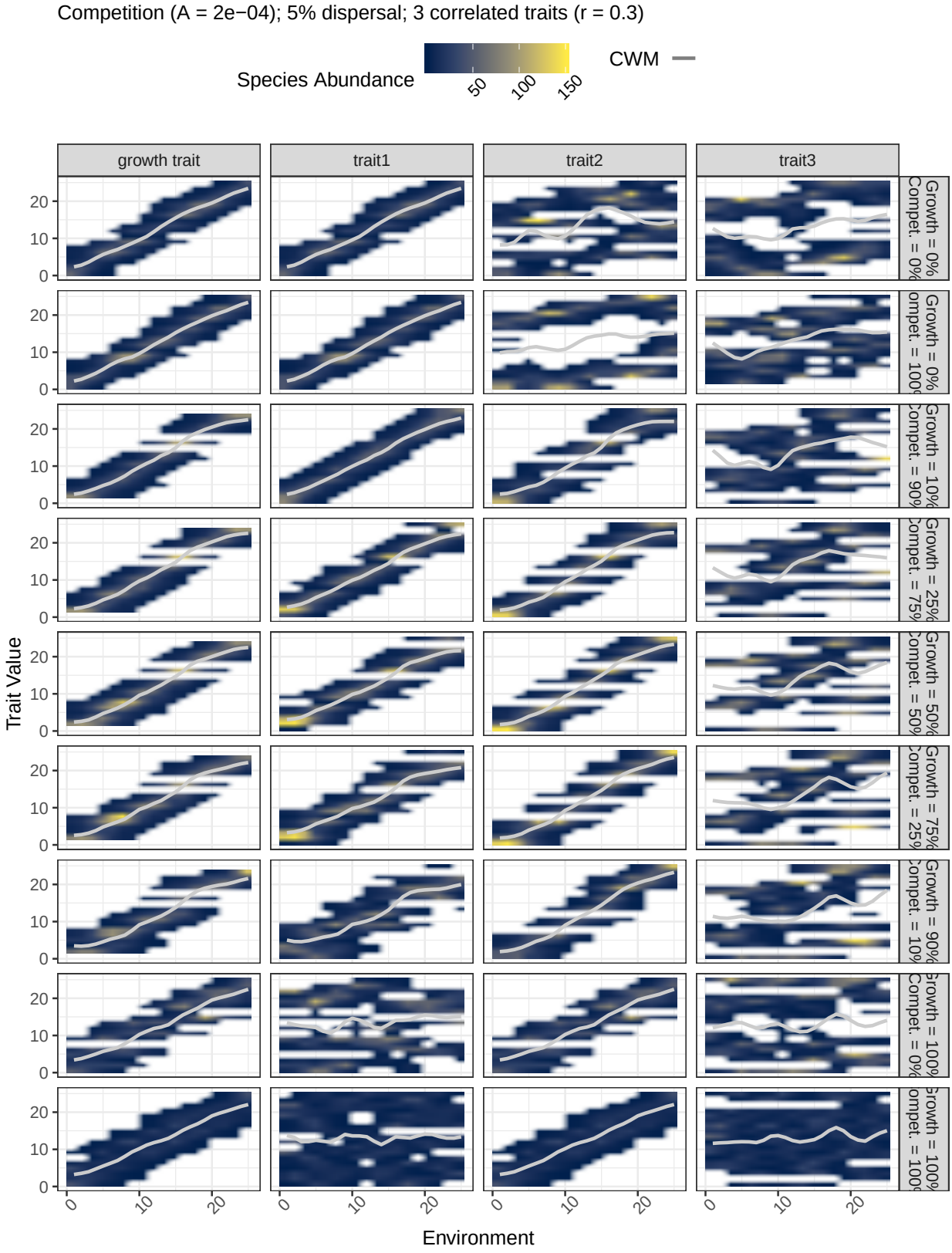


With competition

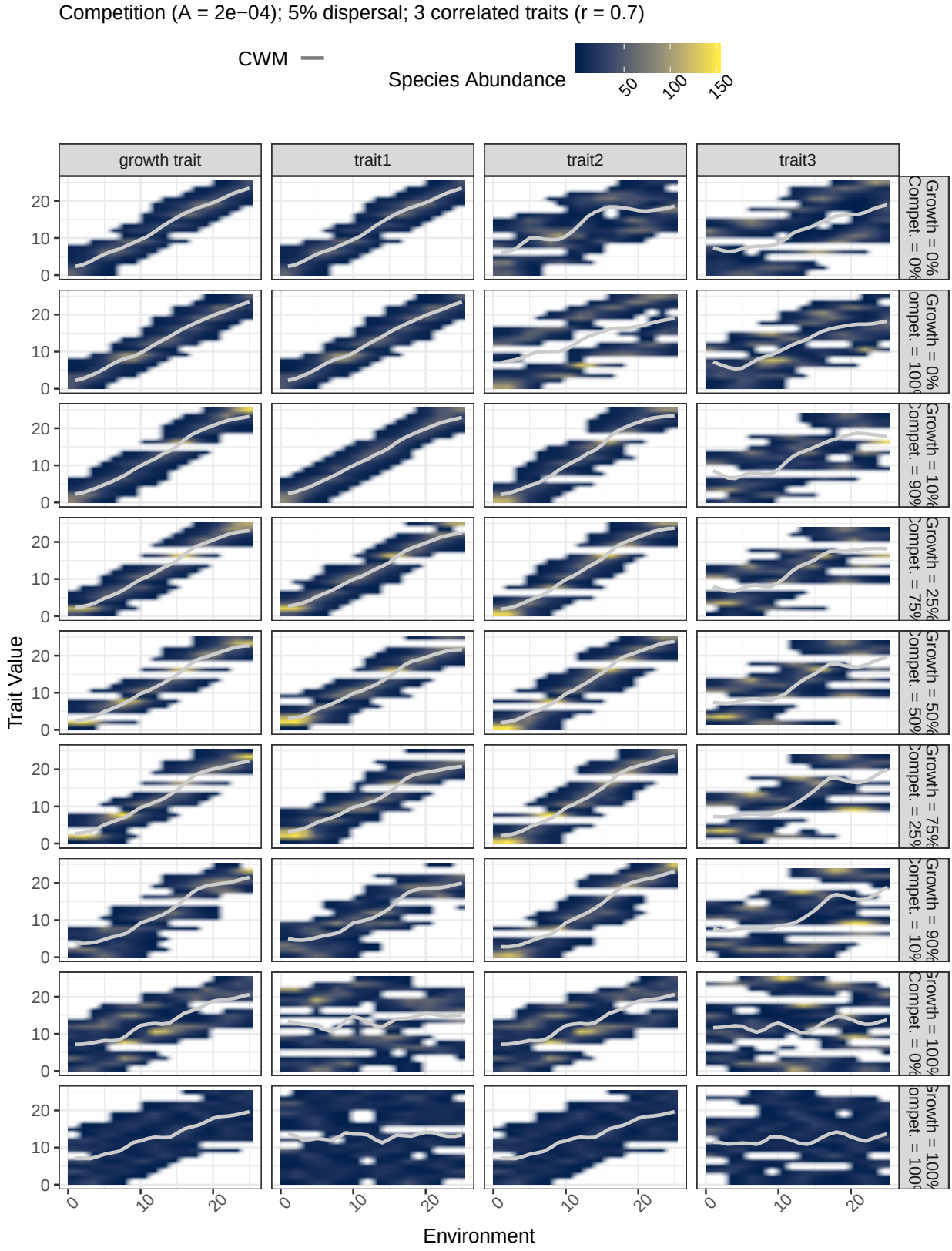
No correlations among traits



Low correlations among traits



High correlations among traits

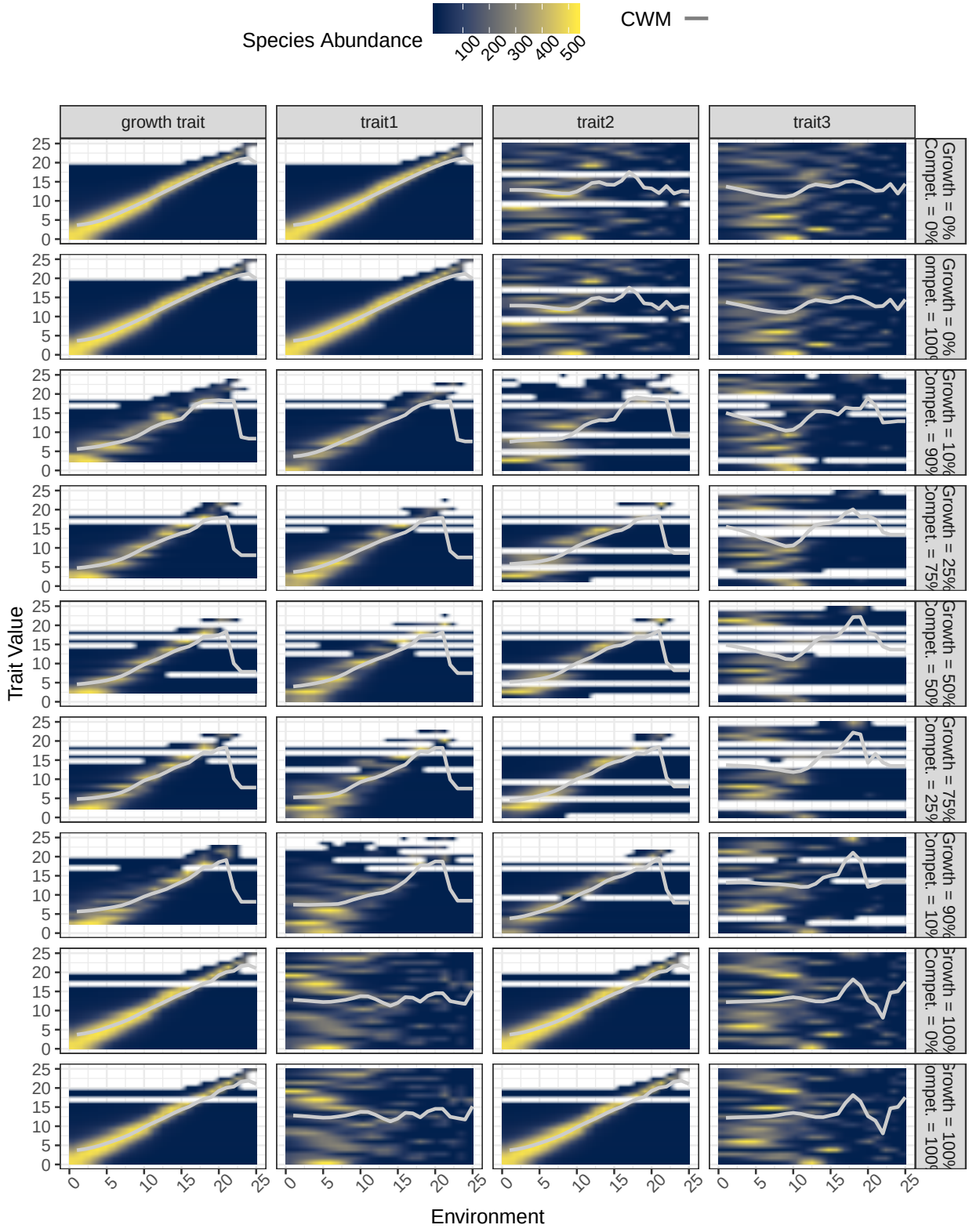


With varying environmental filtering strength

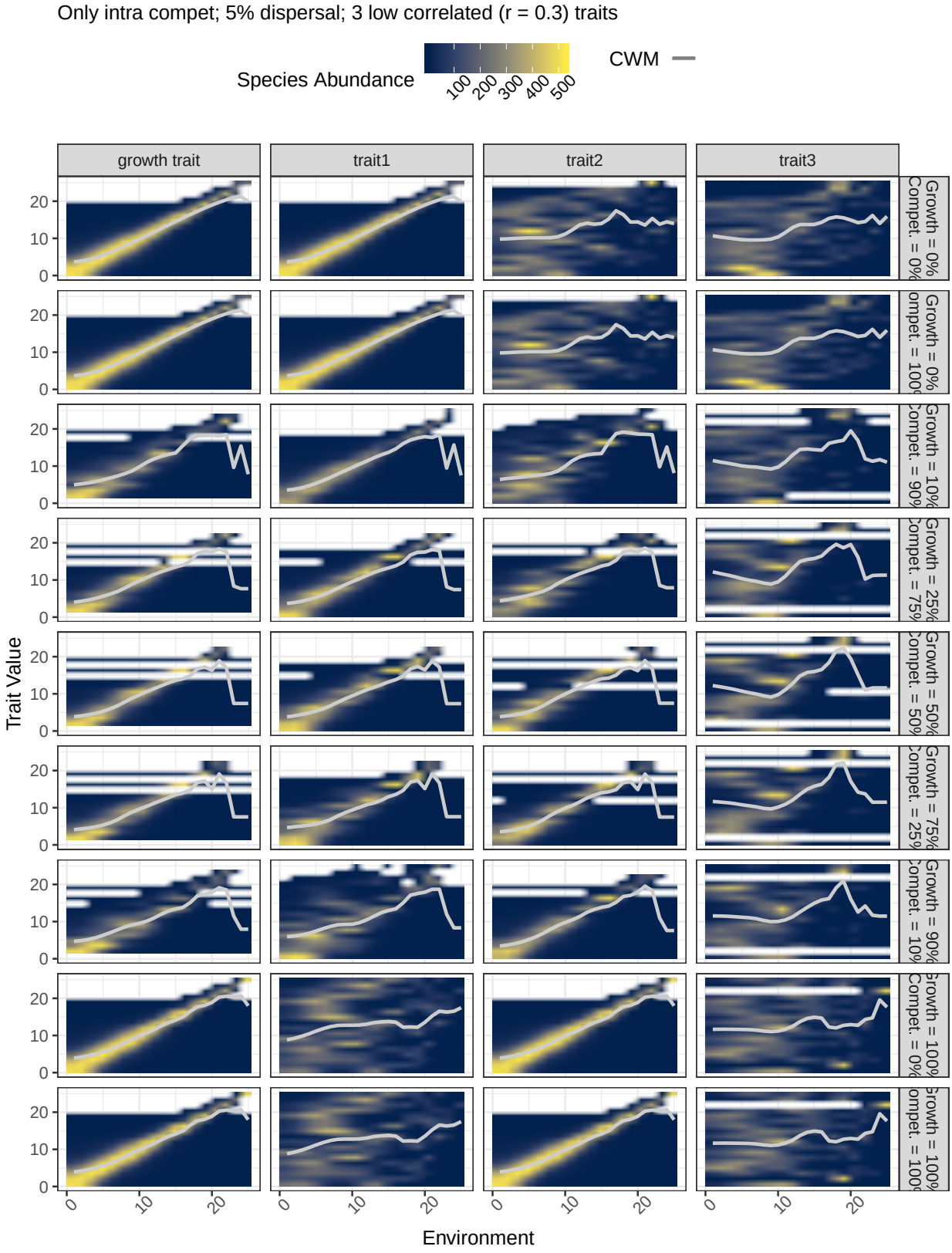
Without Competition (only intra-specific competition)

In this section, the environmental filtering selects for a narrower trait range towards the end of the environmental gradient.

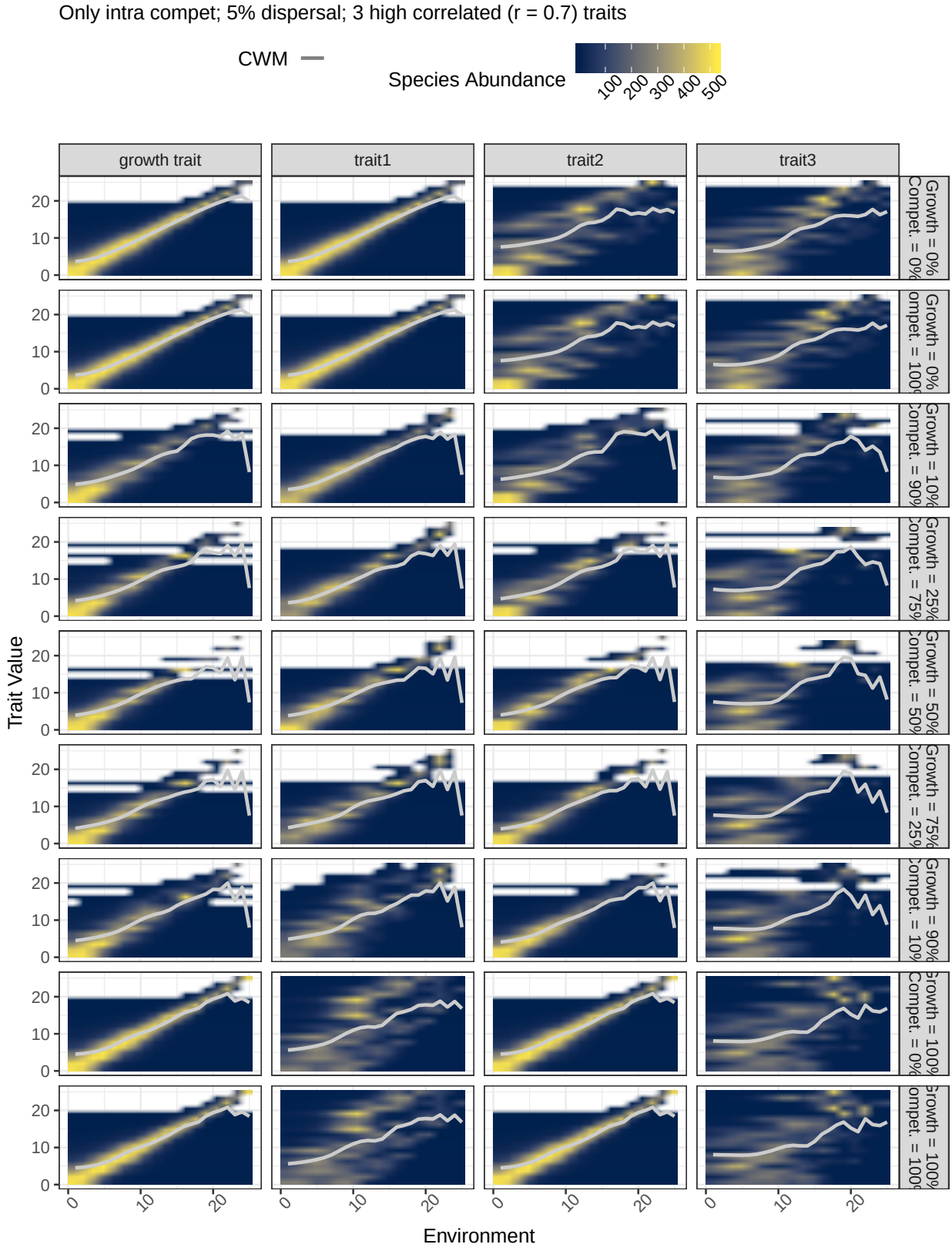
No correlations among traits



Low correlations among traits

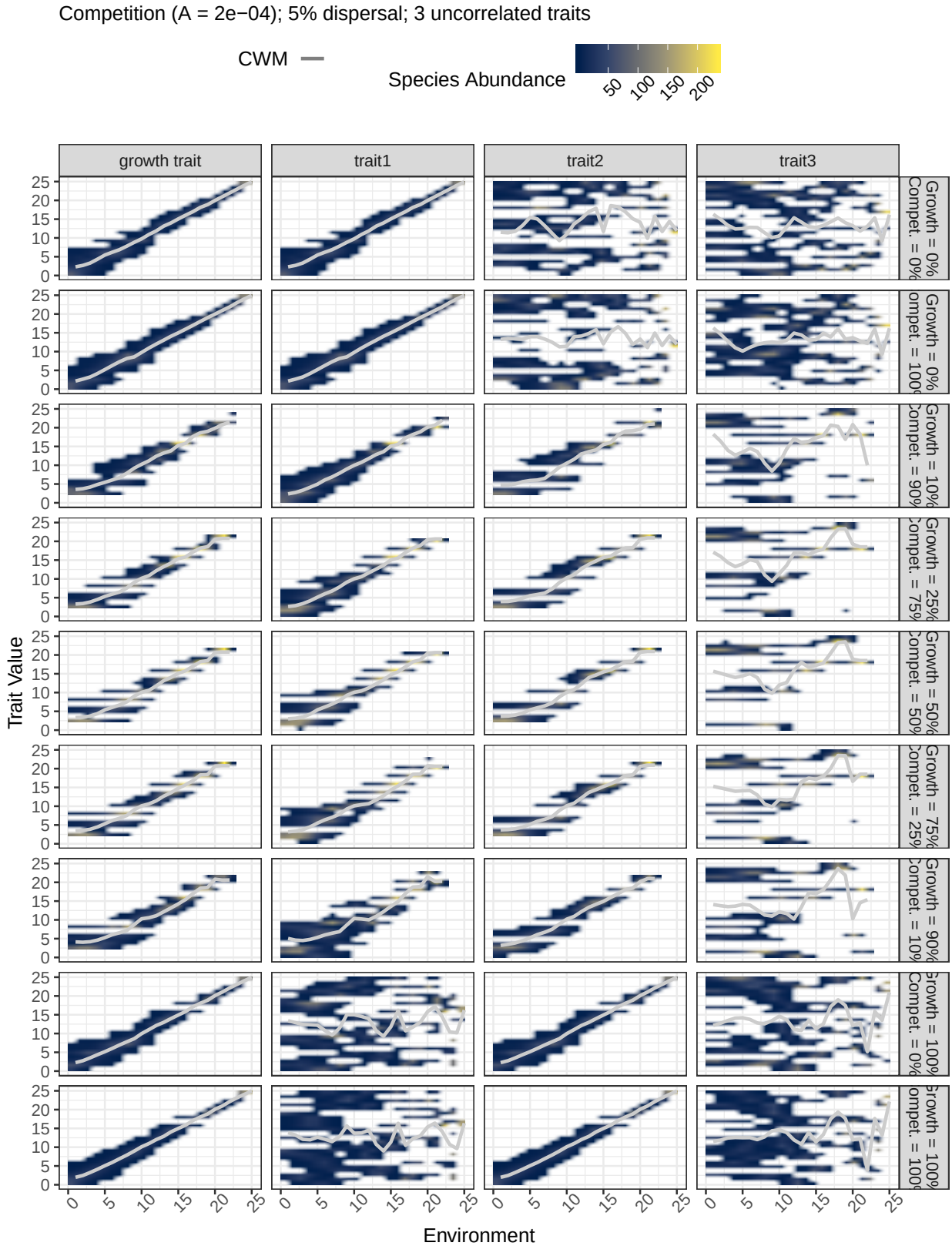


High correlations among traits

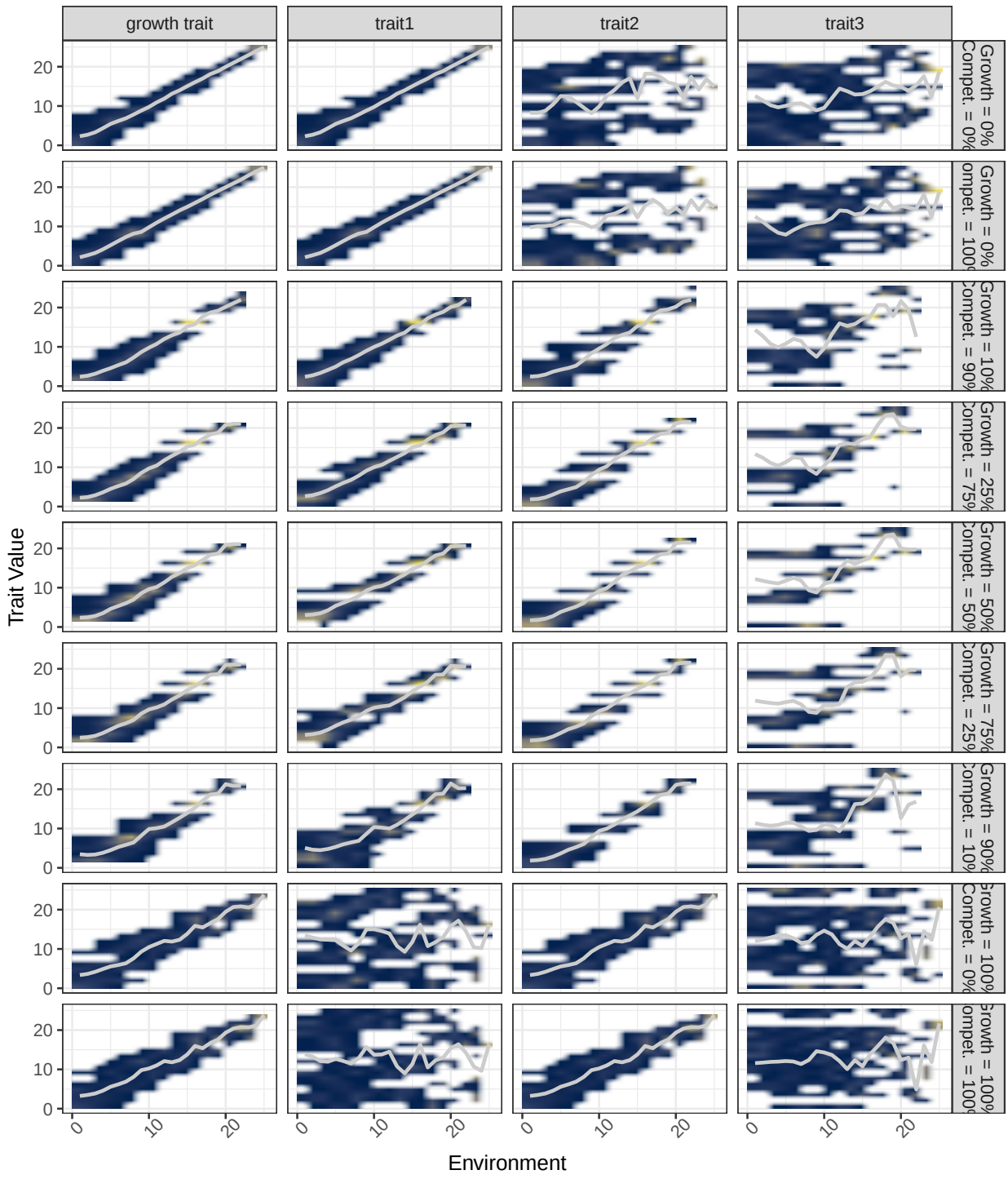


With competition

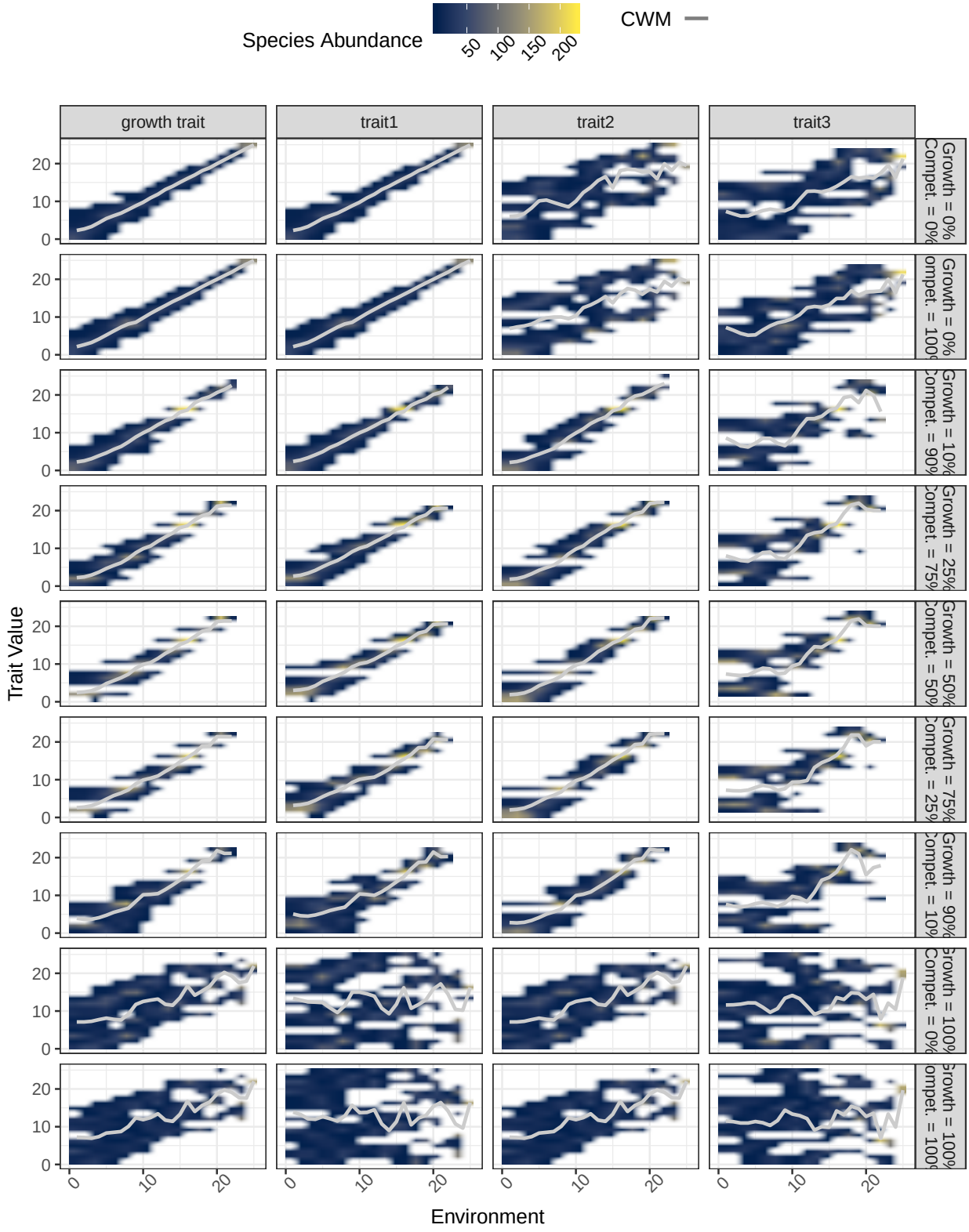
No correlations among traits



Low correlations among traits

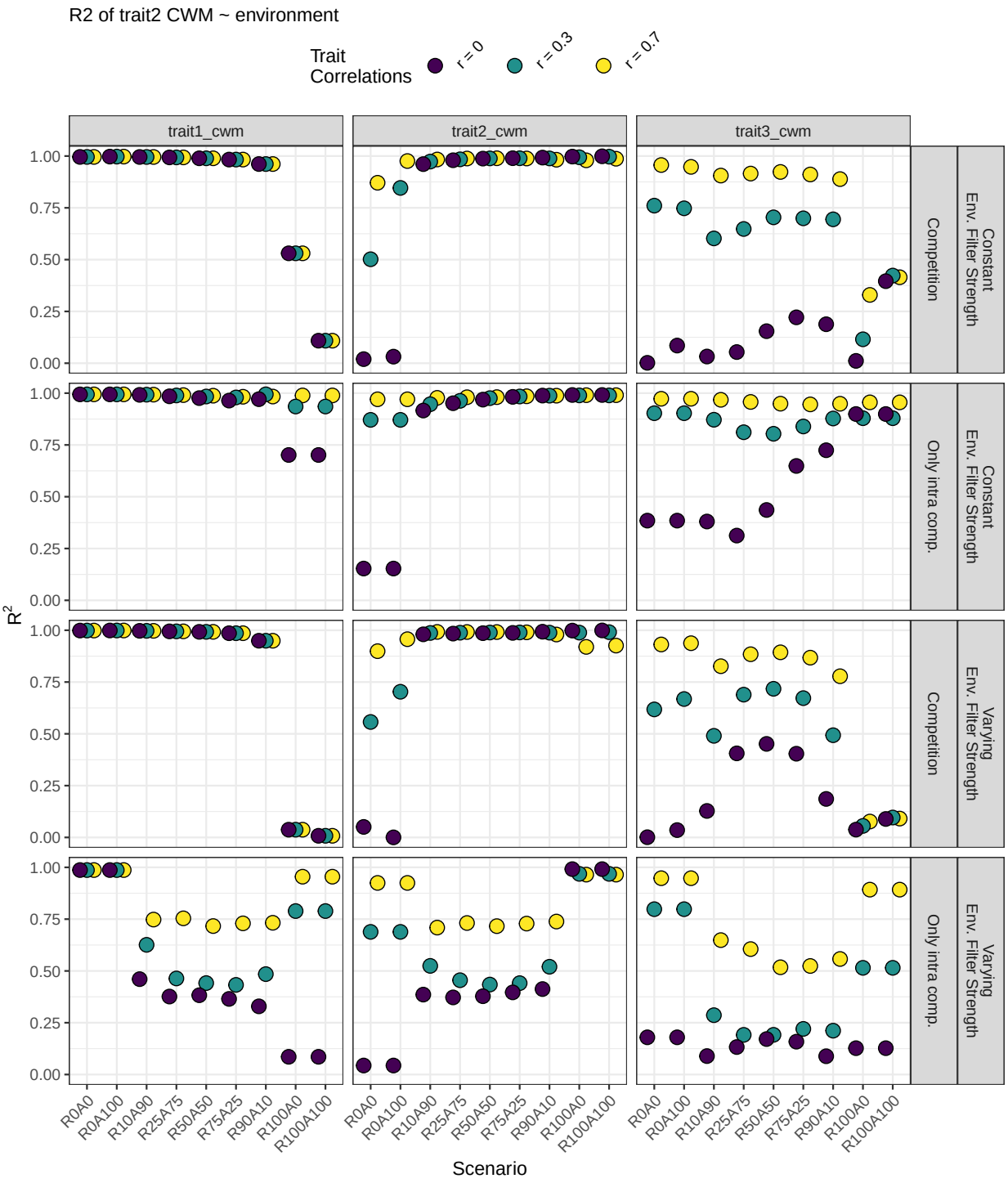


High correlations among traits

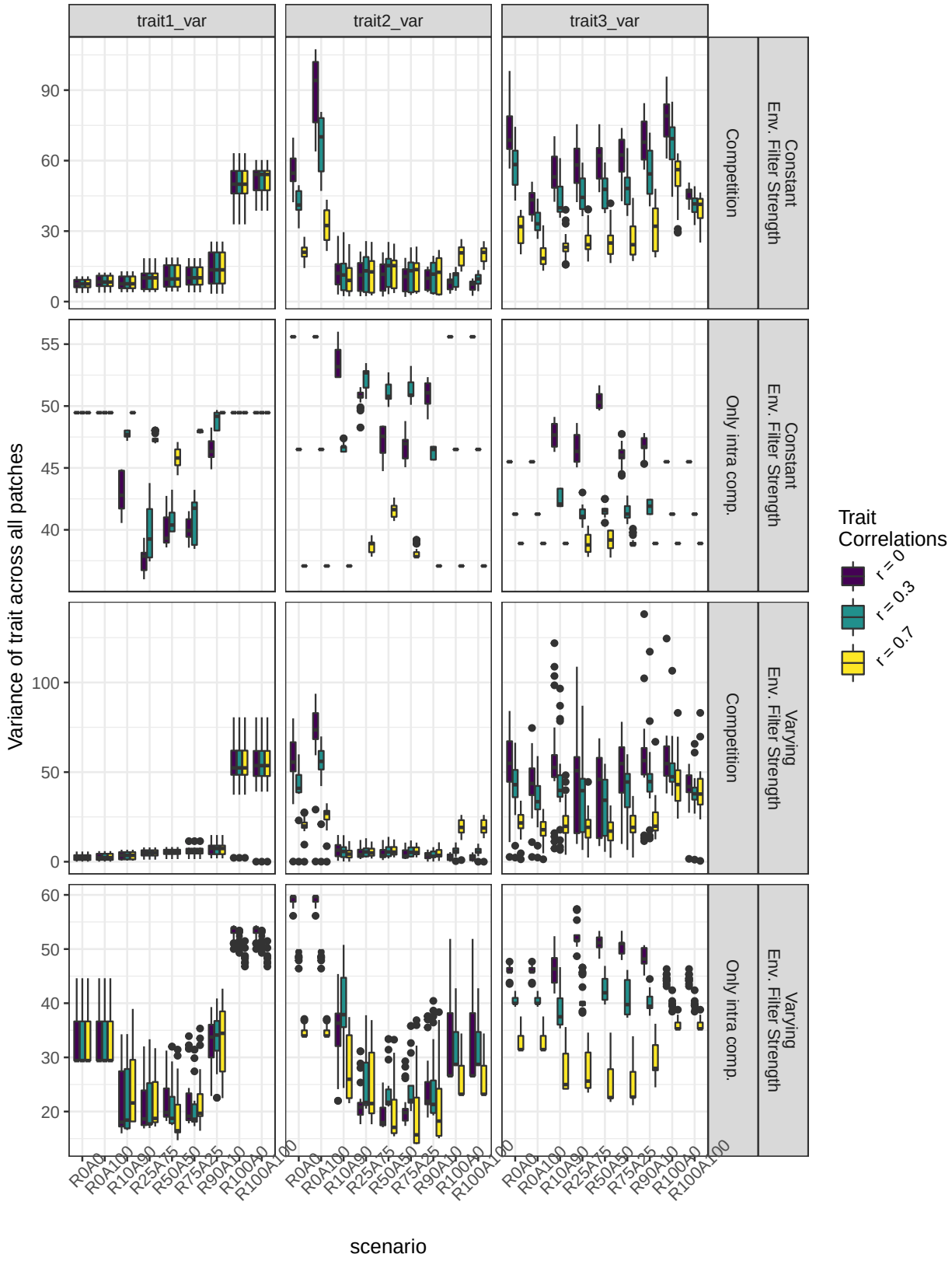


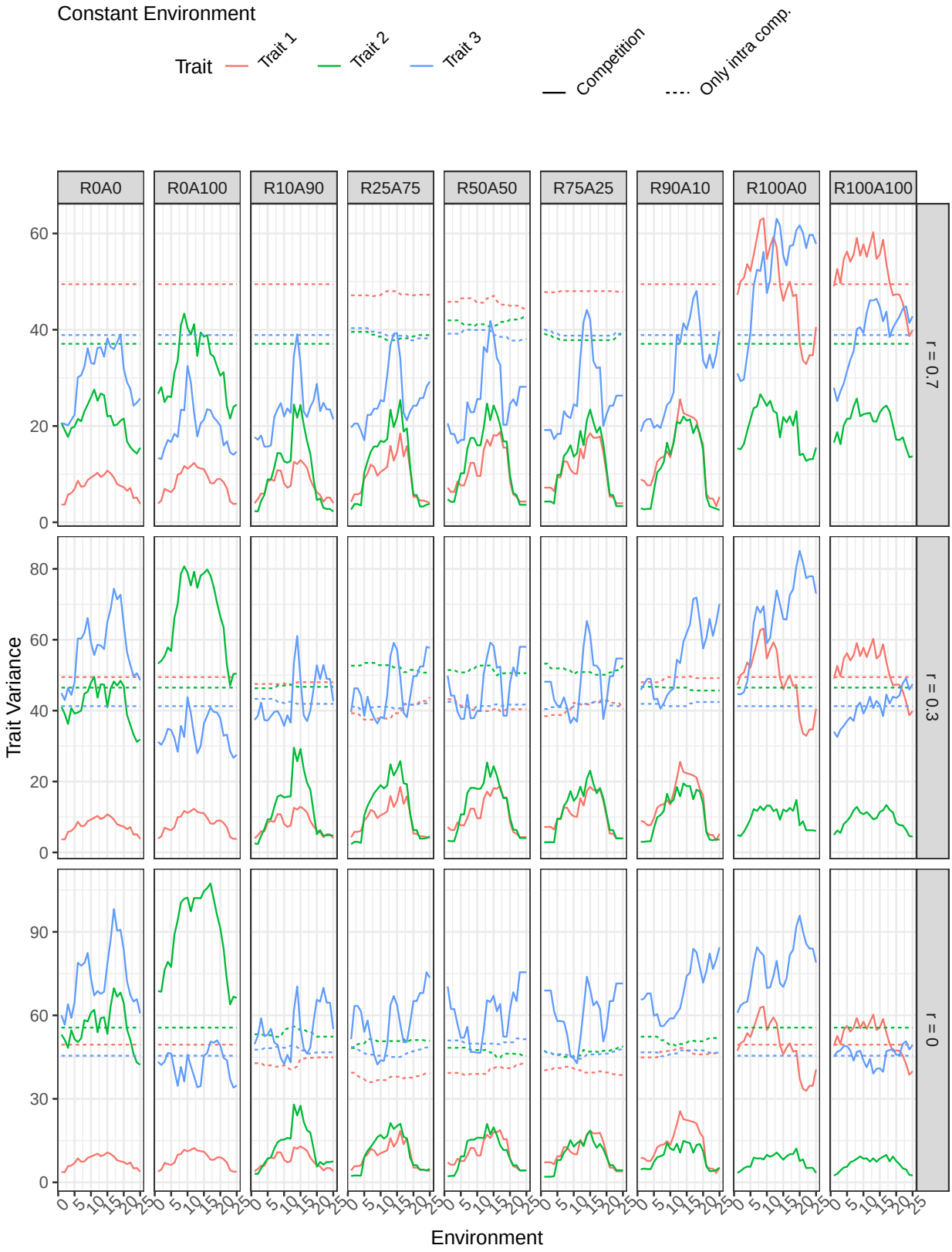
Synthetic plots

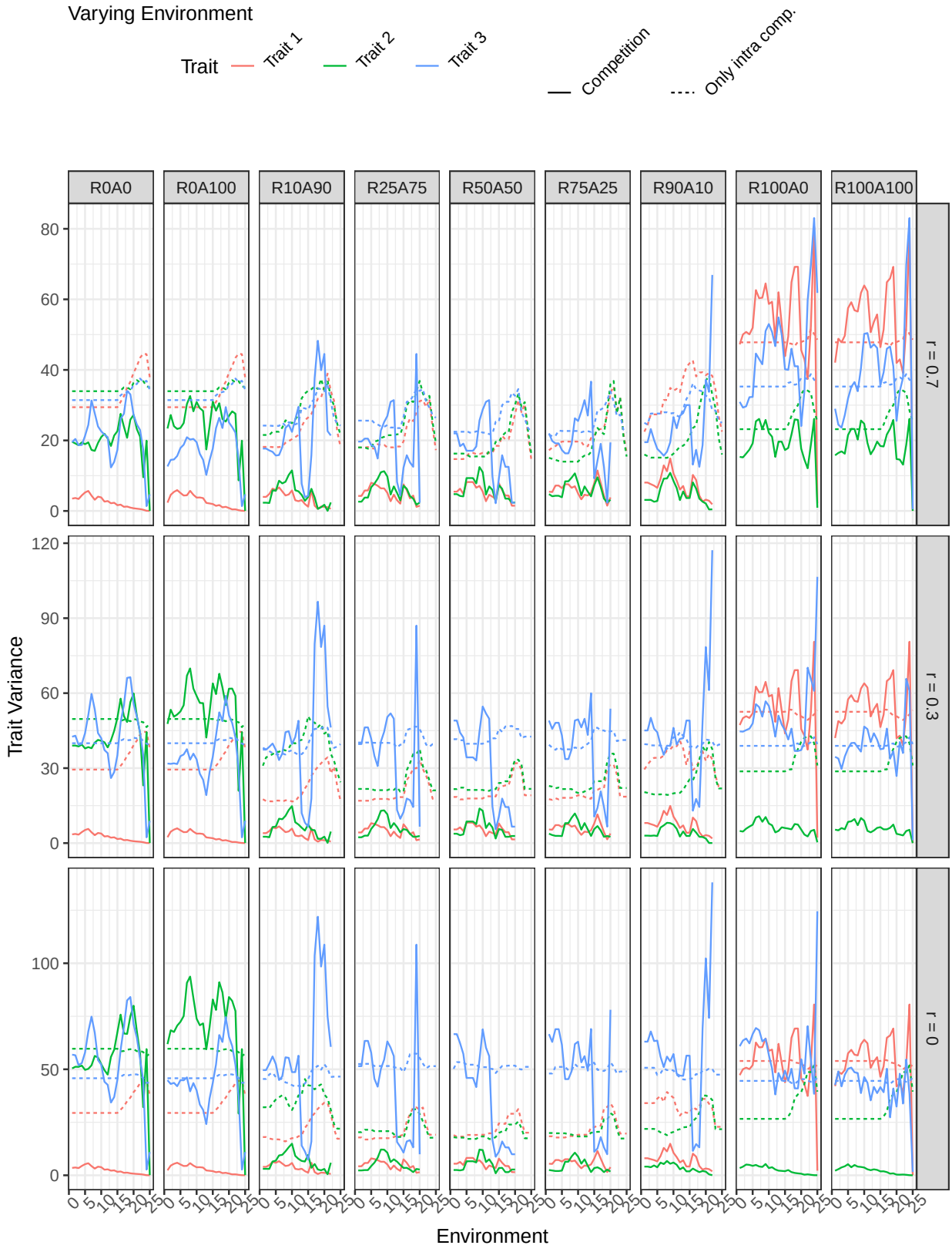
R^2 CWM against environment



Trait variance against environment

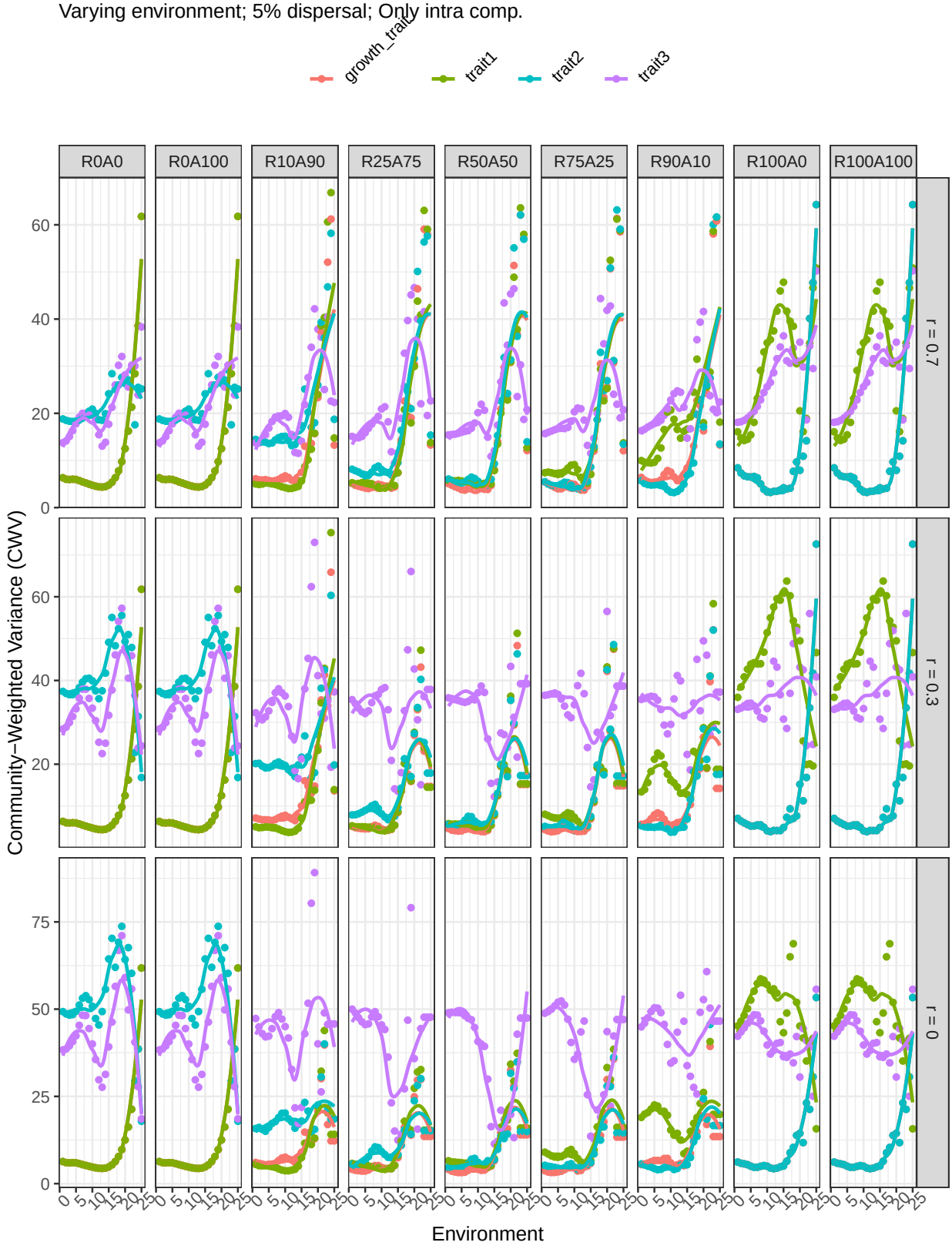



Constant Environment
Trait
Trait 1
Trait 2
Trait 3
Competition
Only intra comp.
R0A0
R0A100
R10A90
R25A75
R50A50
R75A25
R90A10
R100A0
R100A100
r = 0.7
r = 0.3
r = 0
Trait Variance
Environment


Varying Environment
Trait
Trait 1
Trait 2
Trait 3
Competition
Only intra comp.
R0A0
R0A100
R10A90
R25A75
R50A50
R75A25
R90A10
R100A0
R100A100
r = 0.7
r = 0.3
r = 0
Trait Variance
Environment

CWV against environment

Varying environment; 5% dispersal; Only intra comp.



Varying environment; 5% dispersal; Competition