Supporting Information

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Assemblage Complementarity Function

The method for the generation of species traits K and Q has been described in previous work (21). The method is based on the principle that if a species is a good competitor for one resource (relatively lower K_1 when maximum specific growth rates between competitors are equivalent), it is a relatively poor competitor for the other resource (relatively higher K_2). If a species is an intermediate competitor for one resource, it is also an intermediate competitor for the second resource (i.e., has intermediate values for both K_1 and K_2). A linear distribution of species through a K trait space (i.e., K_1 plotted against K_2) can be achieved for an assemblage where the K values for each species follow the simple relationship

$$K_2 = K_{\max} - K_1, \quad \textbf{[S1]}$$

where $K_{\max}$ is the maximum K value for all species combined and K_1 is a number between the minimum value ($K_{\min}$) of all species and $K_{\max}$. This number is drawn uniform randomly from the range $K_{\min}$–$K_{\max}$. This function can be applied to 300 uniform random K_1 values to create an assemblage of 300 species. Note that because the maximum specific growth rates between competitors are equivalent, the distribution of species in the K trait space is equivalent to the distribution of species in the resource tradeoff space.

To adjust the level of complementarity in an assemblage (i.e., increasing it by creating a "downward" curved distribution of species through the resource tradeoff space instead of a linear distribution), the procedure of determining K_2 values required modification. Specifically, we modeled this as

$$x = \left(\frac{1 - F_{\min}}{K_{\max} - K_{\min}}\right)(K_{\max} - K_1) + b, \quad \textbf{[S2]}$$

$$y = \frac{F_{\min}}{x}, \quad \textbf{[S3]}$$

$$K_2 = (y - b)\left(\frac{K_{\max} - K_{\min}}{1 - F_{\min}}\right), \quad \textbf{[S4]}$$

where $F_{\min}$ was a coefficient that defined the shape of the curve (with a value between, but not equal to, 0 and 1), $K_{\max}$ and $K_{\min}$ were the maximum and minimum possible values of K_1, and b was the y intercept when fitting a linear function through data ranges of $[K_{\min}, K_{\max}]$ and $[F_{\min}, 1]$ interpolated to the same number of elements.

Equations Describing the Variation in the Resource Supply

For the baseline scenario where input resource concentrations fluctuate in the range 2–20 μM, the two equations are

$$\text{For resource 1}: R_{\text{inflow 1}} = 11 + 9\cos\left(\pi + \frac{2\pi t}{T}\right),$$

$$\text{For resource 2}: R_{\text{inflow 2}} = 11 + 9\cos\left(\frac{2\pi t}{T}\right),$$

where T is the period.

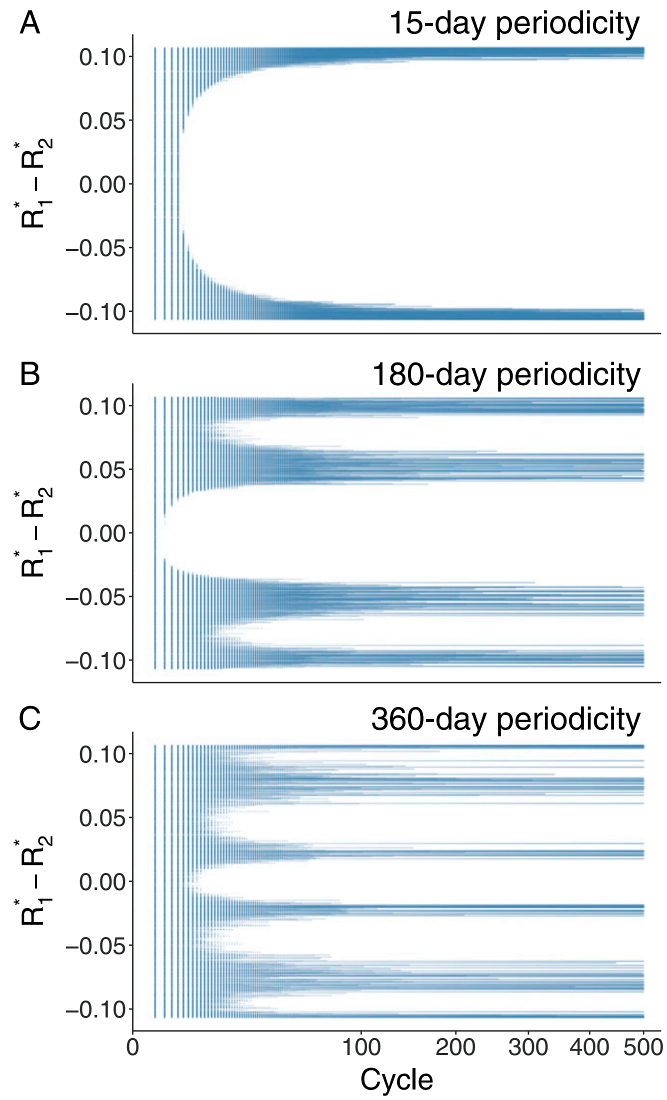

Fig. S1. Dynamics of clump formation over time (resource supply fluctuation cycles) for our focal periodicities of (*A*) 15 d, (*B*) 180 d, and (*C*) 360 d. Blue shading shows the persistence of each of the 300 species from 10 replicate assemblages positioned along the trait axis indicated by the difference in the R^* values for resources 1 and 2.

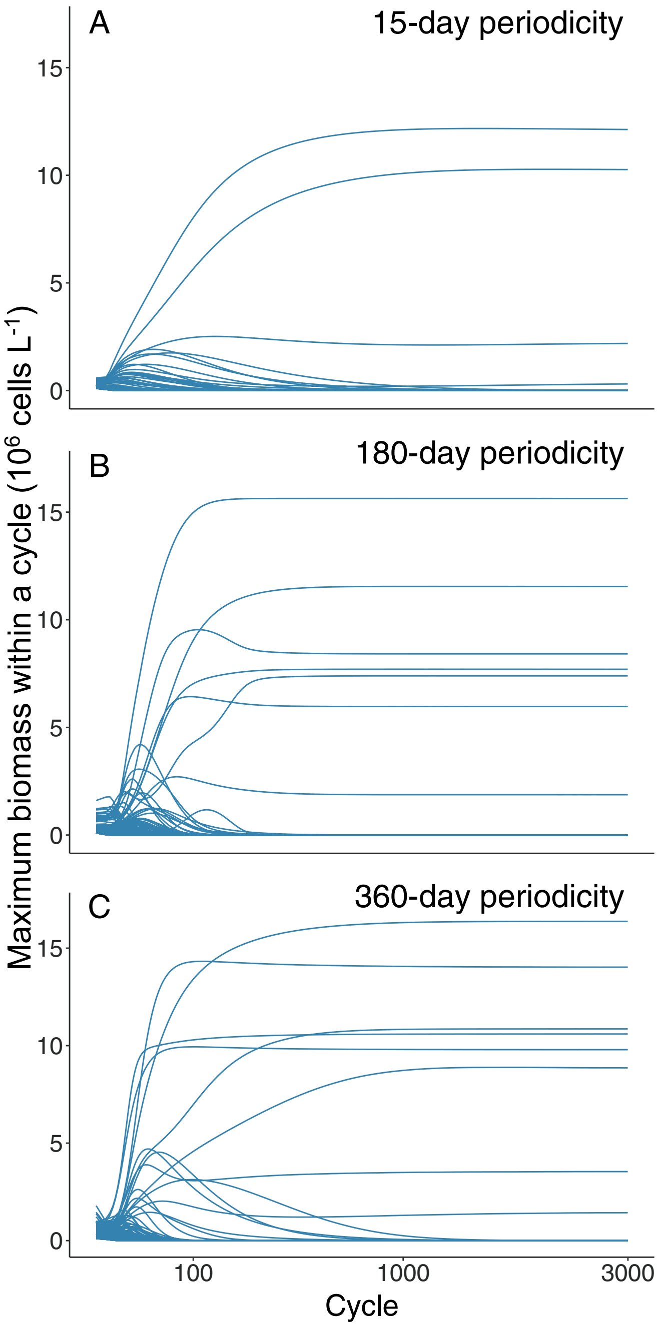

Fig. S2. Dynamics of biomass (expressed as the maximum biomass attained by each species within a resource fluctuation cycle) under the focal periodicities of (*A*) 15 d, (*B*) 180 d, and (*C*) 360 d, when the model was solved for 3,000 resource fluctuation cycles (square root scale).

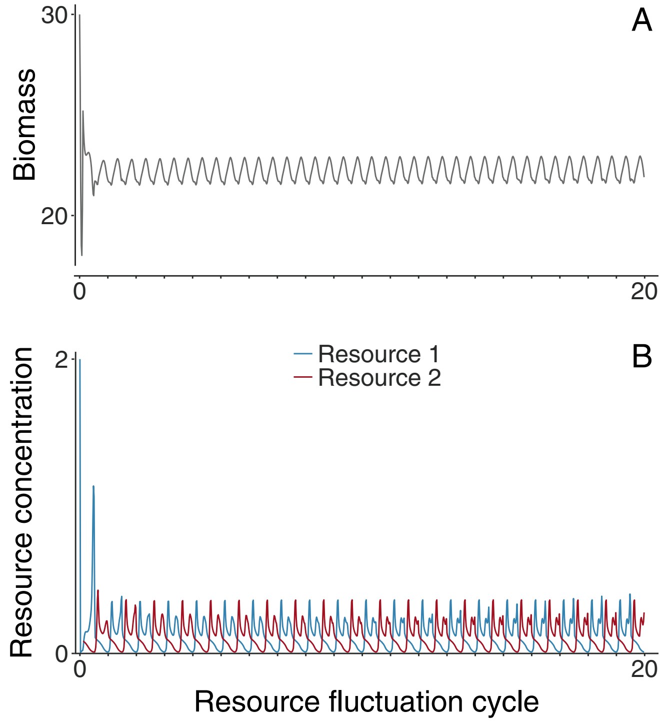

Fig. S3. Dynamics of (*A*) total assemblage biomass and (*B*) available ambient resources 1 and 2 during the first 20 resource fluctuation cycles of the self-organization process for the 180-d fluctuation periodicity, showing early settling into a periodic pattern.

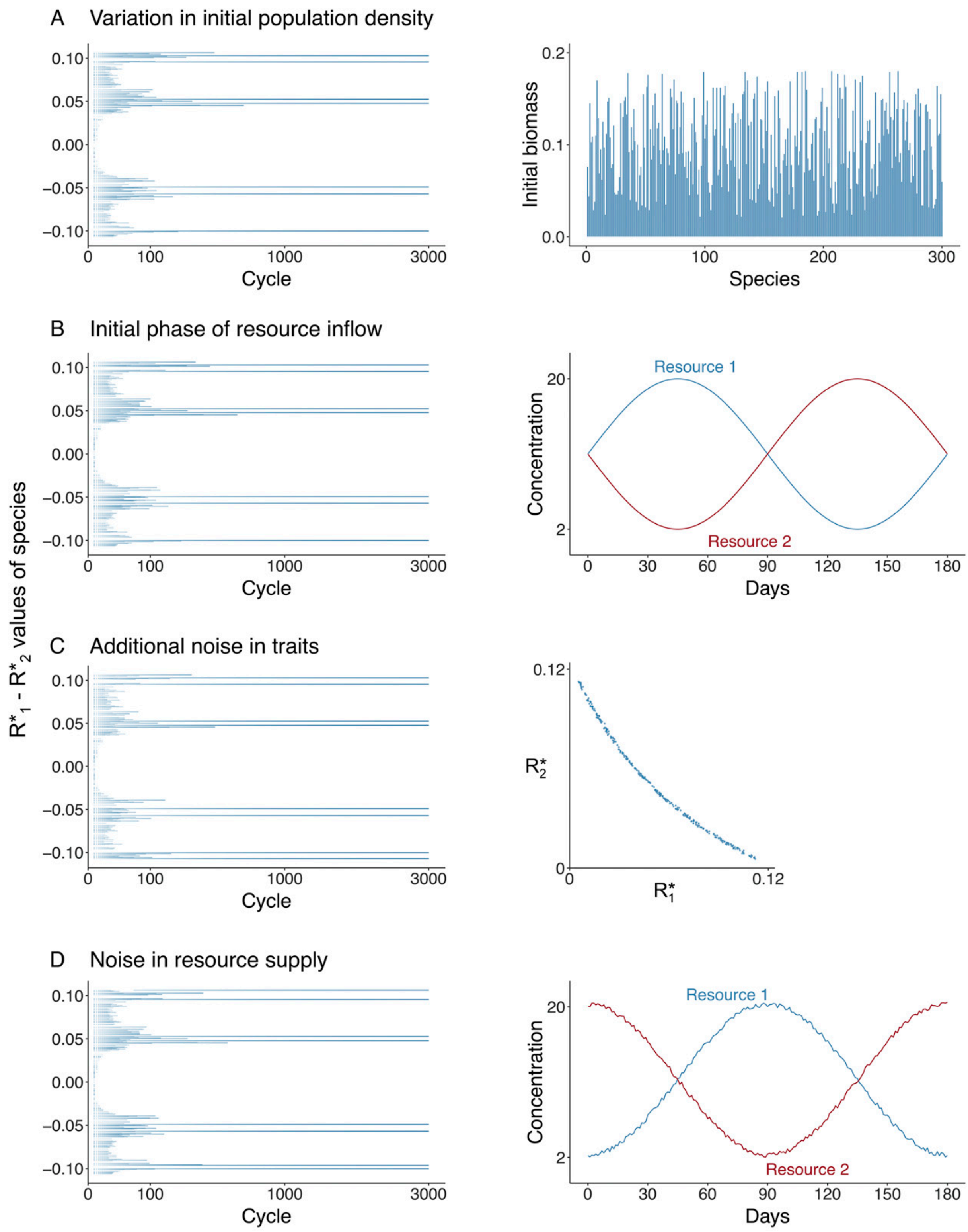

Fig. S4. Dynamics of clump formation over time (resource fluctuation cycles, square root scale) for four scenarios of (*A*) unequal initial population densities, (*B*) resource supply initialization with a phase shift for both resources of $\pi/2$, (*C*) increased stochasticity in species traits, and (*D*) stochasticity in the resource supply concentrations.

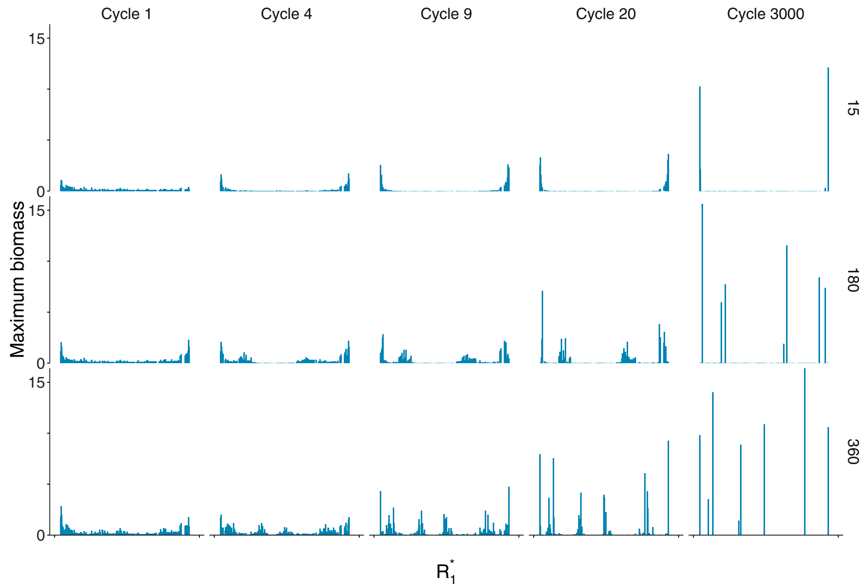

Fig. S5. The distribution of biomass across R^* values for resource 1 at given cycles, for 300 species of a representative assemblage, and for our resource supply fluctuation periodicities of focus—namely, (*Top*) 15 d, (*Center*) 180 d, and (*Bottom*) 360 d. For each periodicity, the biomass redistribution between the 300 species continued until the system was no longer variable between cycles (by cycle 3,000). At all periodicities, species at the extremes of the trait axis (strongest competitors for one of the resources) developed biomass first, while species in the middle (weaker competitors for both resources) were competitively excluded faster.

Table S1. Characteristics of species that survived in the 3,000th cycle of the self-organization process for our resource supply fluctuation periodicities of focus: the competitive ability of species as reflected by the difference in the R^* values for resources 1 and 2, the maximum biomass attained at steady state, the cycle number at which the biomass stabilized, and the clump number with which species were associated

Periodicity	Species ID	R^*_1	R^*_2	Max. biomass at cycle 3,000	Stabilization time, cycle	Clump
15	1	0.0053	0.1118	10.266	1,718	1
	2	0.0056	0.1113	2.188	637	1
	295	0.1093	0.0064	0.306	249	2
	300	0.1116	0.0053	12.126	1,033	2
180	12	0.0073	0.1074	15.633	314	1
	68	0.0231	0.0801	5.969	2,724	2
	80	0.0264	0.0755	7.700	568	2
	221	0.0747	0.0269	1.872	2,259	3
	229	0.0775	0.0249	11.546	801	3
	286	0.1042	0.0086	8.415	1,033	4
	295	0.1093	0.0064	7.393	809	4
360	1	0.0053	0.1118	9.793	2,106	1
	27	0.0125	0.0975	3.539	2,636	2
	39	0.0162	0.0909	14.026	2,452	2
	113	0.0378	0.0613	1.431	169	3
	115	0.0393	0.0595	8.860	1,318	3
	181	0.0587	0.0398	10.859	2,437	4
	259	0.0922	0.0154	16.375	2,885	5
	300	0.1116	0.0053	10.598	2,550	5