SI Text

Biological Interactions Leading to Selection Effects. Although we have no way to determine which biological interactions in prior studies have led to complementarity effects (CE), we can evaluate the common assumption that positive selection effects (SE) occur when species that are most productive in monoculture come to dominate the biomass of polycultures through competition. For each of 34 experiments for which we could acquire data from published figures or original datasets, we calculated the Pearson correlation coefficient relating the biomass of each species i in monoculture Mi to the biomass that same species in the most diverse polyculture Yi. Because all studies used a substitutive design in which species biomasses were initialized as $Yi = Mi / S$ where S is the number of species assigned to a plot, a positive correlation between Yi and Mi indicates that more productive species tend to dominate the biomass of polycultures. The distribution of correlation coefficients was significantly positive with a mean of 0.60 (t = 10.67, df = 33, $P < 0.01$).

A positive correlation between Yi and Mi is not sufficient, by itself, to demonstrate selection effects through competition since a positive correlation is the null expectation whenever there are differences in monoculture yields. However, we can calculate the deviation in the relative yield of each species i from its expected value in monoculture assuming no competitive advantages among species as $\Delta RYi = Yi / Mi - E$, where E is the proportion at which species i was seeded in a polyculture of S species (1 / S). The distribution of correlation coefficients relating Mi to ΔRYi for the same 34 experiments was also significantly positive with a mean of 0.20 (t = 2.90, df = 33, P = 0.01). This indicates that more productive species yielded greater biomass in polyculture than would be expected in the absence of any competitive advantages among species.

We can further demonstrate that the interactions leading to a positive correlation between Mi and ΔRYi were due to competition and dominance by highly productive species, and that this came at the expense of less productive species. To do so, we analyze a smaller subset of studies that have sufficient data to use Fox's (1) recently developed method that divides SE into two components. "Trait-dependent complementarity" (TDC) measures single-species impacts on biomass that are not related to competitive dominance (e.g., when the presence of a legume enhances biomass, but not via dominance over other species). In contrast, the "dominance effect" (DE) measures any increase in the relative yield of one species that is offset by a decrease in the relative yield of another. TDC and DE are calculated as

$$\underbrace{S\,\mathrm{cov}(M_i, \Delta RY_i)}_{\text{SE}} = \underbrace{S\,\mathrm{cov}\left(M_i, \frac{RY_{Oi}}{RYT_O} - RY_{Ei}\right)}_{\text{DE}} + \underbrace{S\,\mathrm{cov}\left(M_i, RY_{Oi} - \frac{RY_{Oi}}{RYT_O}\right)}_{\text{TDC}} \qquad [1]$$

where subscripts distinguish observed (O) from expected (E) yields, and *RYTO* is the sum of observed relative yields across all species (i.e., the relative yield total). For 25 experiments in which we could perform these calculations using original datasets, the total SE averaged 80 $g{\cdot}m^{-2}$ (SD = 144, median = 52). When broken down into the respective components, TDC averaged just 7 $g{\cdot}m^{-2}$ across studies (SD = 40, median = 3.4), whereas DE averaged 74 $g{\cdot}m^{-2}$ (SD = 120, median = 24). The latter is remarkably close to the total SE for these same experiments, which indicate that SE observed in plant diversity experiments stem from competitive interactions that increase the dominance of species with high monoculture yields.

1. Fox JW (2005) *Ecology Letters* 8:846-856.

2. Loreau M, Hector A (2001) *Nature* 412:72-76.