What explains total diversity in a community?

Keystone species can influence diversity
Equilibrium theory of island biogeography
Disturbance
Productivity

Many empirical studies have found a hump-shaped relationship between the productivity of a system and the number of species in that system.
What explains total diversity in a community?

- Keystone species can influence diversity
- Equilibrium theory of island biogeography
- Disturbance
- Productivity
- Habitat heterogeneity

Is biodiversity important for ecosystem structure and function?

- Do ecosystems with high species diversity “function” better?
- Are ecosystems with high species diversity more stable?

Habitat heterogeneity and Biodiversity

- MacArthur and MacArthur (1961) found that the bird diversity of a habitat increased with the complexity of the habitat’s vegetation.
- Similar relationships have been demonstrated in other taxa.

Habitat heterogeneity and Biodiversity

- Ecosystems with more heterogeneous habitats have more potential niches, allowing the coexistence of more species.
Do ecosystems with more species function better?

Empirical evidence shows that in many ecosystems there is a positive relationship between productivity and species richness. But some studies show that there is either no correlation or a negative correlation.

Are ecosystems with more species more stable?

Hypothetical relationship between productivity and species richness

Ecosystems with more species should be more resistant to disturbances and will recover faster than species poor communities.

Are ecosystems with more species more stable?

Hypothetical relationship between species richness and invasion resistance

Species rich communities are less susceptible to invasion because they use more of the available resources.
Do ecosystems with high species diversity “function” better?

What do the empirical data tell us?

1. Experiments in The Ecotron:

The Ecotron is facility designed to establish simplified experimental communities.

- High biodiversity communities had denser canopies and higher photosynthetic rates.
- Low diversity communities also consumed less CO₂.

Are ecosystems with more species more stable?


Experimental design. In a 7-ha field at Cedar Creek Natural History Area, Minnesota, USA, we controlled the number of plant species in 188 plots, each 9 m × 9 m. Plots were randomly assigned to be seeded with 1, 2, 4, 8 or 16 perennial grassland species, with 39, 35, 29, 30 and 35 replicates, respectively, of the diversity levels. The composition of each plot was randomly chosen from a set of 18 perennials (four C₄ grasses, four C₃ grasses, four legumes, four non-legume forbs and two woody species). All plots received 10 g m⁻² of seed in May.
Are ecosystems with more species more stable?

Minnesota grassland plot experiment: resource usage

Tilman et al (1996, 1997) examined the effect of species diversity on productivity and soil nutrients.

Plots with more species less nitrogen in their soil lower resource availability

Figure 1: Dependence of temporal stability of each plot on experimentally imposed species diversity (a) and on resource usage (b). A. Temporal stability for the decade 1994 to 1995 was an increasing function of the number of plant species. Ecosystem stability is the ratio of mean plot total biomass to its temporal standard deviation, determined after detrending. The regression line and its 95% confidence intervals are shown (interaction treatment * number of species, n = 12). B. Temporal stability of each plot was determined by the ratio of total biomass to its temporal standard deviation, determined after detrending. The regression line and its 95% confidence intervals are shown (interaction treatment * number of species, n = 12). A negative intercept was included in all analyses. B. Plot average species temporal stability, determined with species biomass data for 1995-1996, was a declining function of the number of plant species. The regression curve and 95% confidence intervals are based on a fit of temporal stability to log number species, with F_{1,72} = 7.6, P = 0.006.

Some studies show that species rich communities are more productive, but some other studies show alternative interpretation.

Some studies show that species rich communities are more stable and recover from disturbances faster and are less vulnerable to invasive species.

More studies are needed to allow generalizations beyond some model systems.