Janzen-Connell effects in a common shade tolerant tree manifested in 27 year cohort demography (on Barro Colorado Island, Panama)

Kaoru Kitajima
Patric A. Jansen
Carol Augspurger
Ben Bolker
Janzen-Connell Model: Natural enemy causes density-dependent offspring recruitment and greater spacing of conspecific individuals

From Janzen (1970, American Naturalist)

Recent community-wide studies focusing on young seedling stages show weaker negative density-dependency for more common species. But, NDD must operate in order to cap the population size of common species and to contribute to diversity.
“Tachigali versicolor is a suicidal tree.”
Pre-reproductive canopy *Tachigali* 1985

The same tree dead after reproduction, 2006
Survival and height growth monitored in two seed shadows from 1985 to 2012

One transect (5 m wide x 100 m long) at each site

N = 2974  
N = 2306

Kitajima & Augspurger 1989 Ecology
Augspurger & Kitajima 1992 Ecology
*Tachigali versicolor*'s young seedlings show weak (net negative) density-dependency.

(Kitajima & Augspurger 1989 Ecology)
Continuously shade suppressed seedlings (15-24 yrs old) with efficient leaf display (median leaf lifespan 4.5 yrs)
Slow density dependent mortality increased the mean dispersal distance of offspring from the parents, erasing the spatial signature of seed dispersal (i.e., high concentration of offspring near the parent).

Kitajima, Jansen, Augspurger (in prep)
Offspring density against distance

Dispersed seed density at Site A (Blue) and Site B (Red)

Seedling density at 2, 10 and 20 years old
Ricker function fit of seedling density at germination, 5, 10, 15, 20 & 25 yrs

Fits on log scale (years coloured by rainbow rather than by colour gradient).
Ricker function fit of $\log_{10}(\text{density})$ at germination - 25 yrs
Relationship of 5, 20 & 25 yr old seedling density against seed density in each 5 m x 5 m subplot

NDD created even distribution of seedling distribution after two decades.
Leaf pathogen causes premature loss of leaves and death of apical meristem. Resilience through resprouting.
Height growth of 7.5-24 yrs seedlings with individual IDs

24 year old (38 cm tall)

10 yr old (28 cm tall)

Numbered metal tag
Leaf display in shade --> gap --> shade

Shade - Monolayer  Gap - Multilayer  Shade - Monolayer

Release  Re-suppression
Leaf display in shade --> gap --> shade

Shade - Monolayer

Gap - Multilayer

Shade - Monolayer + Foliar Disease

Release

Re-suppression
NDD is gradually manifested by a foliar pathogen in a shade tolerant specie.

From Janzen (1970, American Naturalist)
Conclusion

• Unidentified pathogen causes leaf disease and premature leaf loss, especially in saplings that appear to be released and then shaded again.
• The disease-caused mortality results in negative density dependent (NDD) survival in established seedlings and saplings.
• At seed and seedling stage, NDD is weak and not sufficient to support the J-C model.
• Over 20 yrs, NDD creates even offspring density as predicted by the J-C model.
Epilogue

Camilo Zalamea and Carolina Sarmiento are isolating fungi from diseased spots of expanding young leaves.
THANK YOU, Carol.