Filling the stomach of the enemy: how does seed masting work?

Group #1

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• Introduction

  What is seed masting?
  Types of masting.
  Hypotheses for masting.

• Methods

  Variables
  Models
  Simulations

• Results

• Conclusion
What is mast seeding?

Masting is the intermittent synchronous production of seeds at long intervals by a population of plants.

\[ V_{seed} = V_{env} + V_{mast} - V_{const} \]
Types of masting

Strict masting

- Bimodal seed output with **no** overlap between tails.

- When highly synchronized, mast years can be objectively distinguished.

- Shown only for highly synchronized monocarps, e.g. bamboo and *Strobilanthes*. 
Types of masting

Normal masting

- Bimodal seed output with overlap between tails (statistically significant bimodality).
- Statistical identification of mast years is sample-size dependent.
- Example: genus *Quercus*.
Types of masting

Putative masting

- Seed output varies greatly but no evidence for switching.
- Not really masting, unless bimodality or switching is shown.
- Example: most published papers on masting.
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Possible ecological advantages of masting

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- Wind pollination
- Accessory costs
- Animal pollination
- Animal dispersal
- Resource matching
- Large seed size
- Environmental prediction
- Predator satiation
Possible ecological advantages of masting

“Economies of scale” = larger reproductive efforts are more efficient, favouring occasional large efforts rather than regular smaller ones.

Predator satiation
Is masting a good strategy?
Single-Species Model

\[
\frac{dT}{dt} = \alpha S - d_T T - \frac{T^2}{K_T}
\]

\[
\frac{dS}{dt} = r_S T - r_P \frac{SP}{f + \gamma S} - d_S S - \alpha S
\]

\[
\frac{dP}{dt} = r'_P \frac{SP}{f + \gamma S} - d_P P - \frac{P^2}{K_P}
\]
Single-Species Model - Results

- Satiation

- Masting

Forest model w/ Trees, Seeds, and Predators

Population vs. Time (arbitrary units)

+ Satiation

+ Masting

Forest model w/ Trees, Seeds, and Predators

Population vs. Time (arbitrary units)
Two-Species Model

\[
\frac{dT_1}{dt} = \alpha S_1 - d_T T_1 - \frac{T_1(T_1 + T_2)}{K_T}
\]

\[
\frac{dT_2}{dt} = \alpha S_2 - d_T T_2 - \frac{T_2(T_1 + T_2)}{K_T}
\]

\[
\frac{dS_1}{dt} = r_{s_1} T_1 - r_P \frac{S_1 P}{f + \gamma(S_1 + S_2)} - d_s S_1 - \alpha S_1
\]

\[
\frac{dS_2}{dt} = r_{s_2} T_2 - r_P \frac{S_2 P}{f + \gamma(S_1 + S_2)} - d_s S_2 - \alpha S_2
\]

\[
\frac{dP}{dt} = \tilde{r}_P \frac{(S_1 + S_2) P}{f + \gamma(S_1 + S_2)} - d_P P - \frac{P^2}{K_P}
\]
Two-Species Model - Results

Forest model with Two Tree Species, Seeds, and Predators

Population vs. Time (arbitrary units)

- Red line: Tree 1 Population
- Green line: Tree 2 Population
- Blue line: Seed Population
- Dashed line: Predator Population
Two-Species Model - Results

Forest model w/ Two Tree Species, Seeds, and Predators

Population vs. Time (arbitrary units)
Two-Species Model - Results

Masting and non-masting final populations

Difference

Gamma predation factor
Conclusion

The single-species model is not enough to show the evolutionary advantage of masting over non-masting.

When predator satiation is amplified and there is competition for the same carrying capacity, masting is more advantageous than not masting, which leads to the extinction of the non-masting population.
Limitations

- Time delay (maturation)
- Dispersal/migration
- Specialist predators
- Random cycles
- Semelparity/iteroparity
- Stochasticity.
Thank you!