Larval developing in phloem

Evaluating the role of iteroparity and predation in populations of *Dendroctonus frontalis*

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Female excavating oviposition gallery

Abstract

• Southern pine beetles (SPB), *Dendroctonus frontalis* are functionally iteroparous because adult females spread oviposit ion over multiple host trees via reemerging behavior.

• We dissected field-captured female adults to differentiate individuals that had and had not previously mated.

  • This is a measure of iteroparity -- increased proportion of previously mated females indicates greater iteroparity.

• High predation could decrease iteroparity. We tested this by comparing the degree of iteroparity in two SPB populations before and after a predictable seasonal decline in the abundance of the predator *Thanasimus dubius.*

• > 95% of females reemerged from trees after oviposition, presumably seeking additional trees.

• Between-tree survival increased from 50 to 80%, when the predator: prey ratio decreased from 1 : 5 to 1: 100.

• Thus, iteroparity may be very common.

• Increased iteroparity (e.g., via decreased predation) hastens convergence on a stable stage distribution.

  •The degree of iteroparity influences the probability of local extinction or pestilence.

• Increased iteroparity may have evolved in this species as a strategy to limit the risk of very low fitness caused by intense larval competition in some trees.

Questions:

1) How common is reemergence in SPB populations?

2) What is between-tree survival probability?

2a) Do predators limit survival probability?

3) What are population-level consequences of reemergence?

Females may reemerge to attack multiple trees

Trapping landing females

Sites: We made observations in two beetle spots in AL in the Talladega National Forest in 2005. The spots were ≈ 20km apart, both in stands dominated by *Pinus taeda* aged 25-50. Early observation were done 5-8 July, late observation were done 26-27 July.

Question 1) How common is reemergence in SPB populations?

Methods: We removed bark from trees that had been attacked by SPB, after all oviposition was complete. The probability of reemerging is (1- probability of dying within the tree). By observing the number of attacks and the number of dead females within the bark, we calculate reemergence rates.

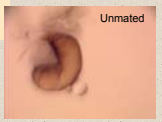
Results: Reemergence probabilities ranged from 94-98%

Rare observation of mortality within a tree

Question 2) What is between-tree survival probability?

Methods: We hung 12-unit Lindgren traps on all trees under attack. The sampled population of females is a composite of virgins coming out of their brood tree, and previously mated females which have reemerged from subsequent trees. We dissected and observed the spermatheca and pump of all females to determine the proportion of mated females in each population. Because

$$P\ mated = N_{mated} / N_o + N_{mated}$$



and

$$N_{mated} = N_o \sum_{b=1}^{\infty} (P_{survival})^b \times (P_{reemerge})^b$$

we can solve for $P_{survival}$ using the infinite geometric expansion series and find

$$P_{survival} = P_{mated} / P_{reemerge}$$

One assumption of this solution is that the populations are at a stable stage distribution. We checked this and describe the results of that study under Question 3.

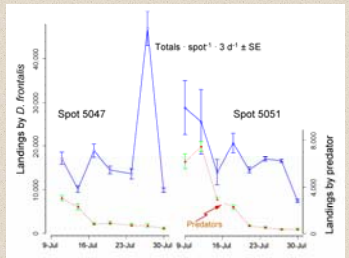
Results: Survival in early July was 49 ± 6 % and increased to 80 ± 8 % by late July.

Question 2a) Do predators limit survival probability?

Predator and bark beetle

Methods: We placed sticky traps on trees where beetles were landing, and counted the number of *T. dubius* predators and SPB that landed on each tree.

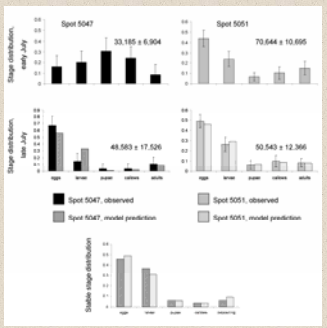
Results: Predators declined substantial between the early and late sampling (Predator : Prey ratio declined from 0.20 ± 0.06 to 0.01 ± 0.01). This coincides with the observed increases in survival.



Question 3) What are population-level consequences of reemergence?

Methods: We observed the stage structure of both populations by quantifying the life-stages present under the bark. Using a temperature-based beetle development model, which used demographic parameters observed from bark from each spot, we iterated the model until it converged on the stable stage distribution. We compared the predicted stable distribution to what we observed at each spot.

Results: One spot was near its predicted stable stage distribution, which for SPB, is dominated by early life stages. The two populations behaved independently.



Conclusions:

• Observed reemergence was very high.

• Between-tree survival increased when predator populations declined.

• In some spots, females may oviposit in multiple trees.

  • Observed per capita reproduction in a tree may only represent a fraction of a female's lifetime reproduction.

• Reemergence increases the rate a population reaches a stable stage distribution.

  • When spots start in the spring, they are synchronous (all adults). Over time they reach a stable distribution.

• Reemergence increases the flying / attacking beetle population which means there is less likely to be a period when there are no attacking beetles—decreased probability of a spot becoming inactive.

Future Consideration:

•What variables influence reemergence rates?

• If females regularly oviposit in multiple trees how should we estimate per capita reproduction?

• Do patterns of iteroparous vs. semelparous behavior across *Dendroctonus* species reflect common evolutionary histories?

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