Windows of Selection & Dominance

Changing selection pressure for insecticide resistance in the months after spray and net deployments

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The role of windows of selection and windows of dominance in the evolution of insecticide resistance in human disease vectors

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Abstract

Persistent insecticides sprayed onto house walls, and incorporated into insecticide-treated bednets, provide long-acting, cost-effective control of vector-borne diseases such as malaria and leishmaniasis. The high concentrations that occur immediately postdeployment may kill both resistant and susceptible insects. However, insecticide concentration, and therefore killing ability, declines in the months after deployment. As concentrations decline, resistant insects start to survive, while susceptible insects are still killed. The period of time after deployment, within which the mortality of resistant individuals is lower than that of susceptible ones, has been termed the "window of selection" in other contexts. It is recognized as driving resistance in bacteria and malaria parasites, both of which are predominantly haploid. We argue that paying more attention to these mortality differences can help understand the evolution of insecticide resistance. Because insects are diploid, resistance encoded by single genes generates heterozygotes. This gives the potential for a narrower "window of dominance," within the window of selection, where heterozygote mortality is lower than that of susceptible homozygotes.

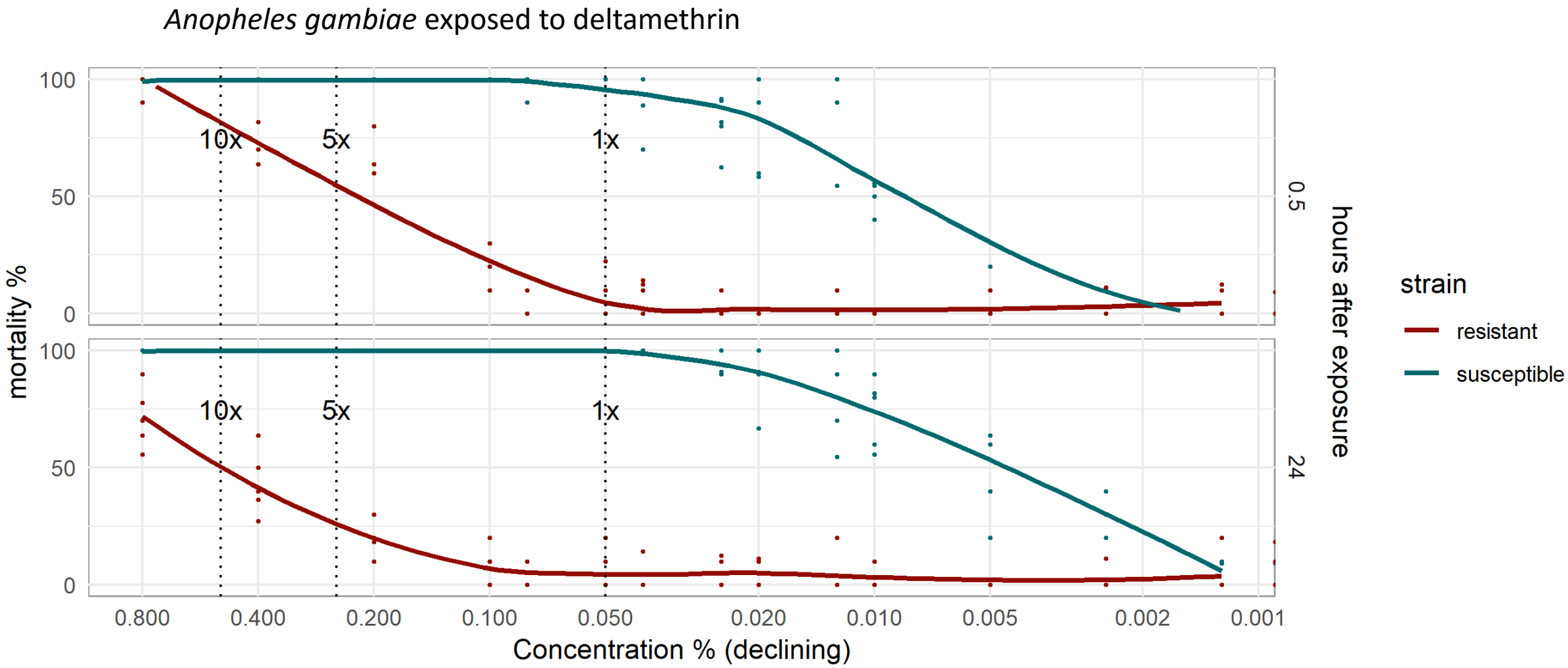
Metrics

Details

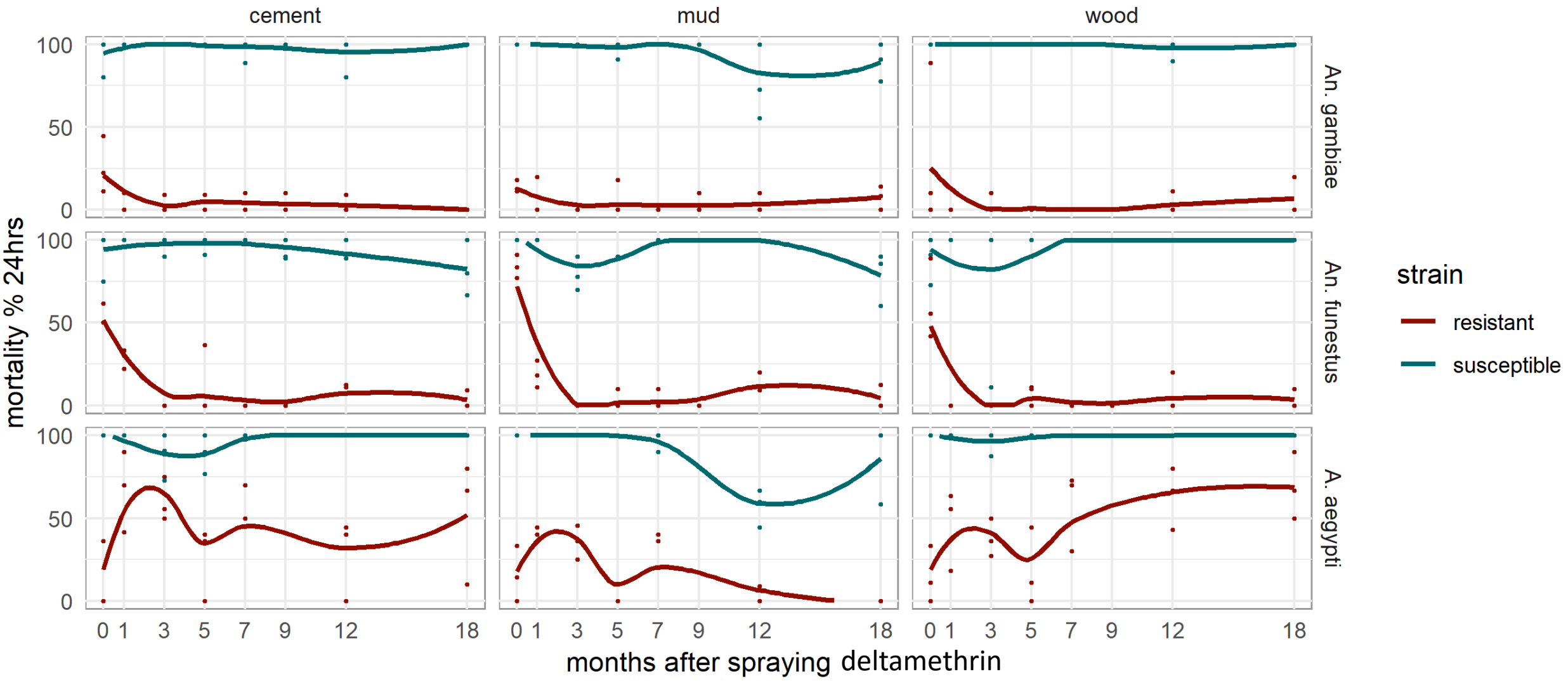
Keywords

dose–response
drug resistance
insecticide resistance
insecticide resistance management
malaria
vector-borne diseases

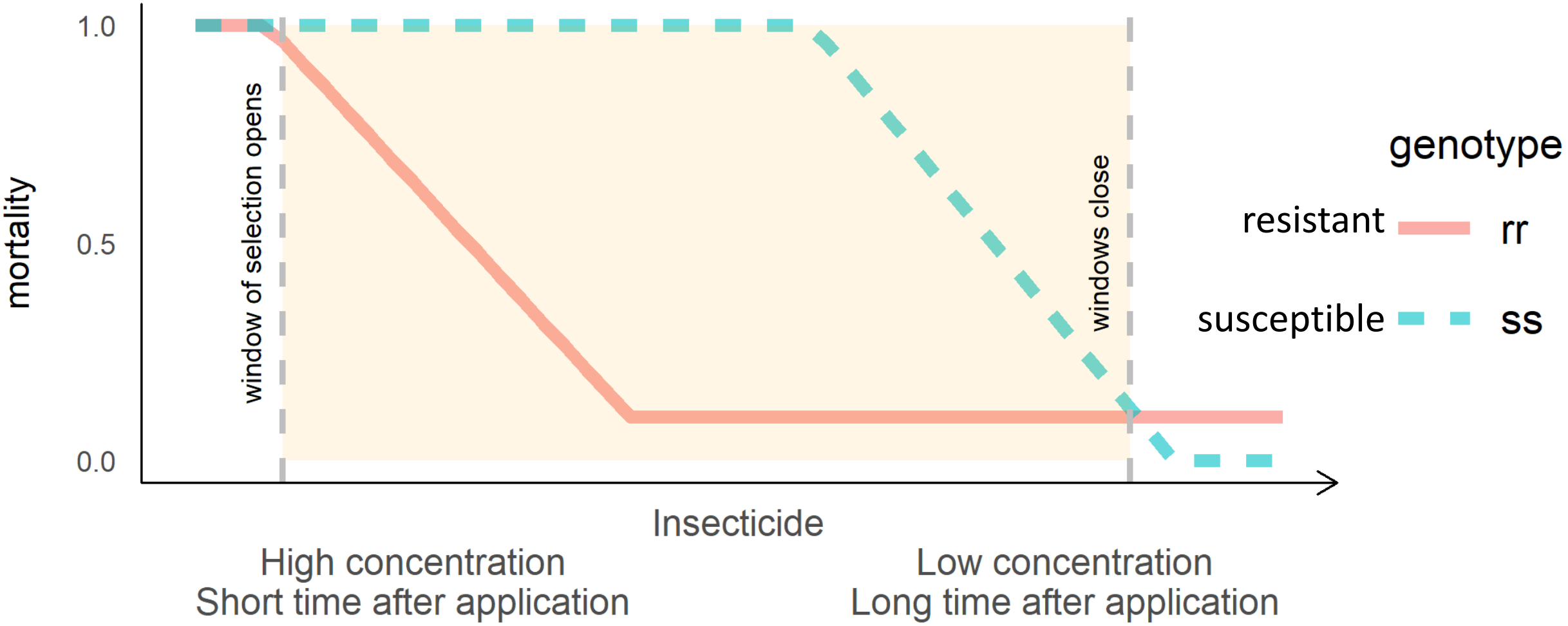
Laboratory experiments - concentration



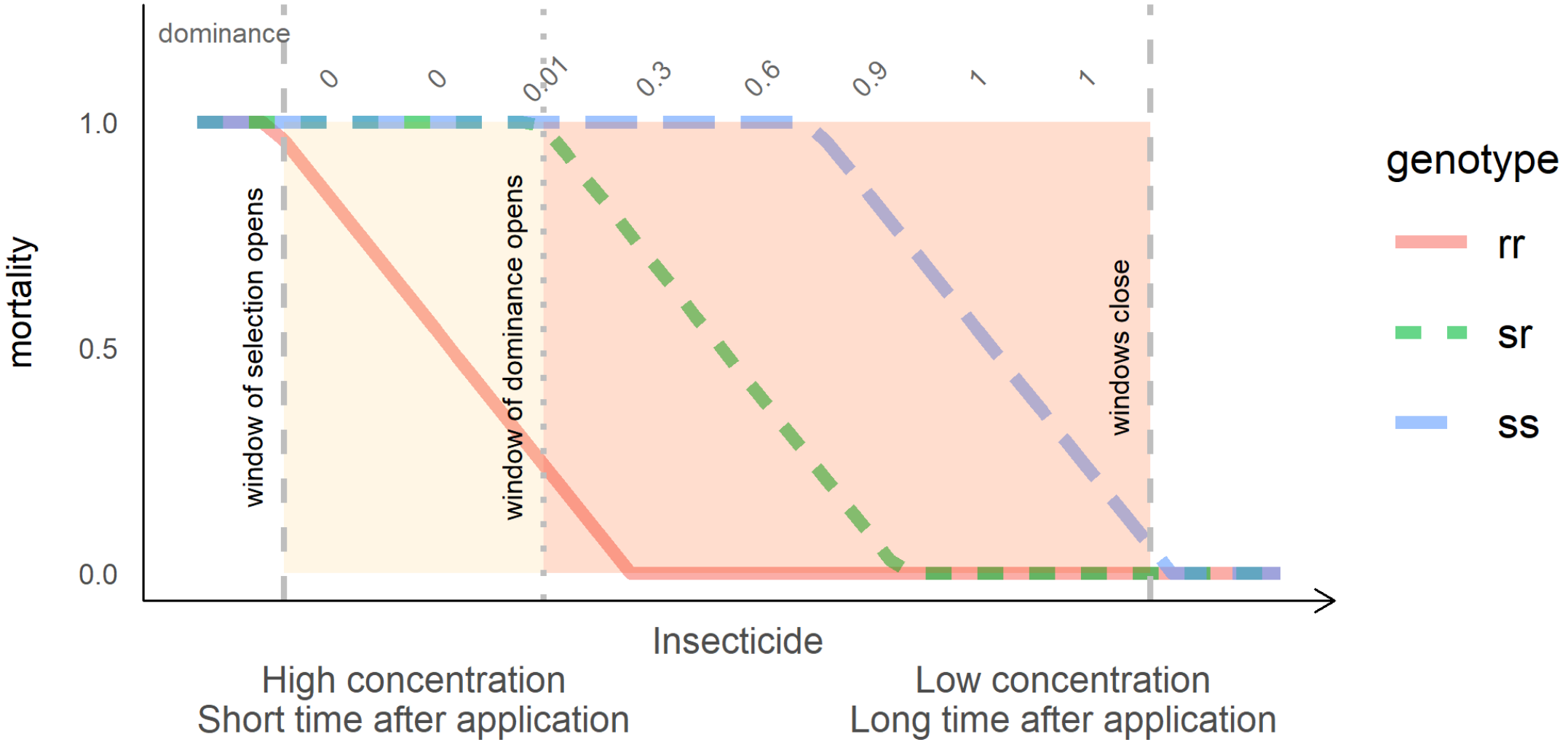
Laboratory experiments - time



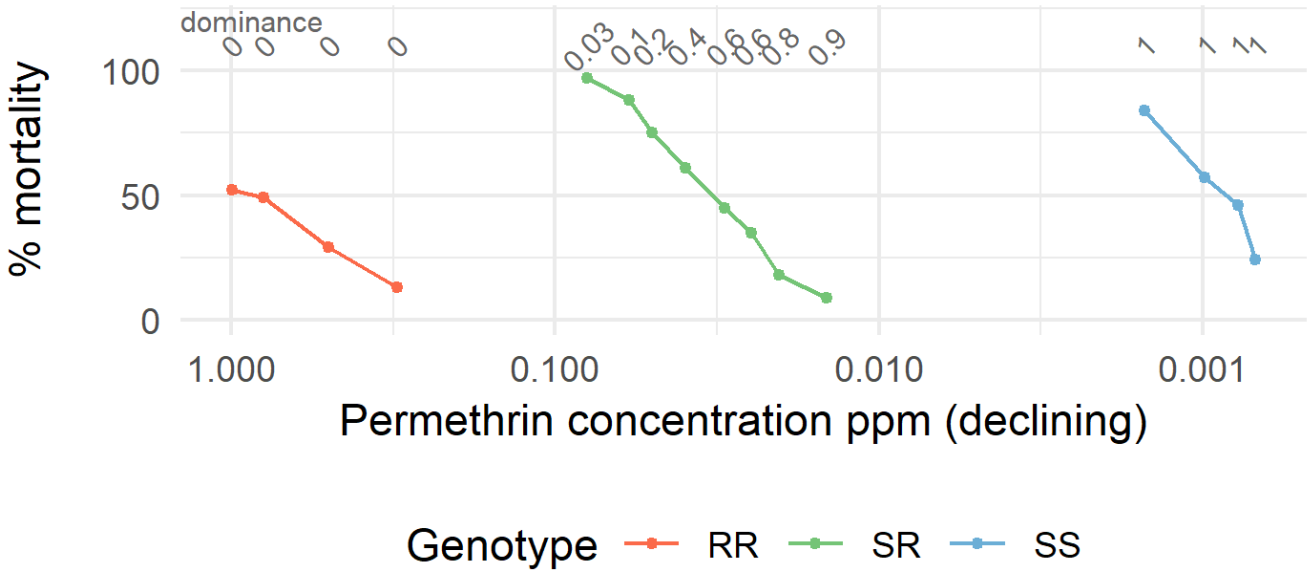
Window of selection

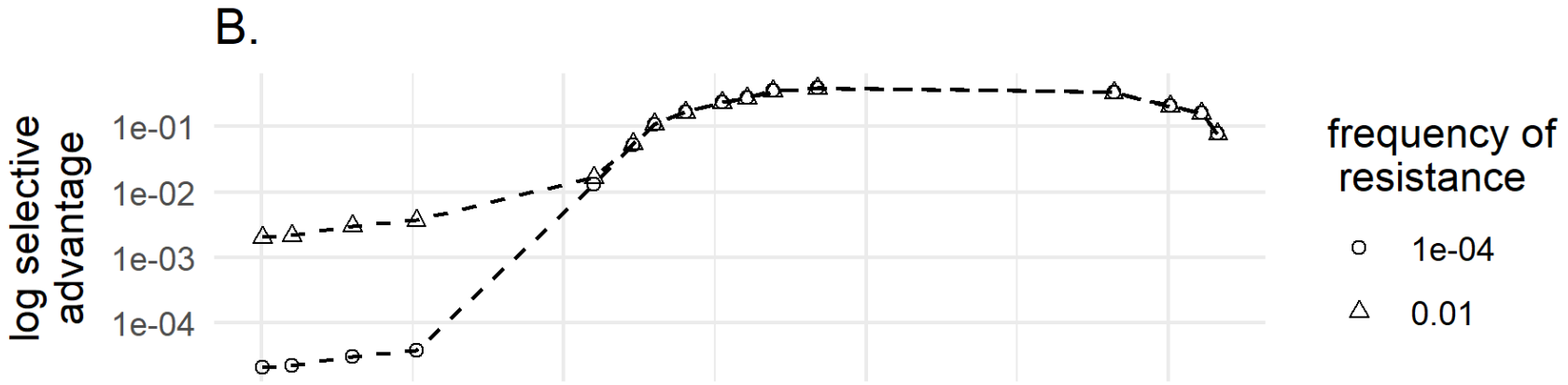


Window of dominance – mortality of partially resistant lower than susceptible



Window of dominance for *Culex quinquefasciatus* larvae exposed to permethrin.





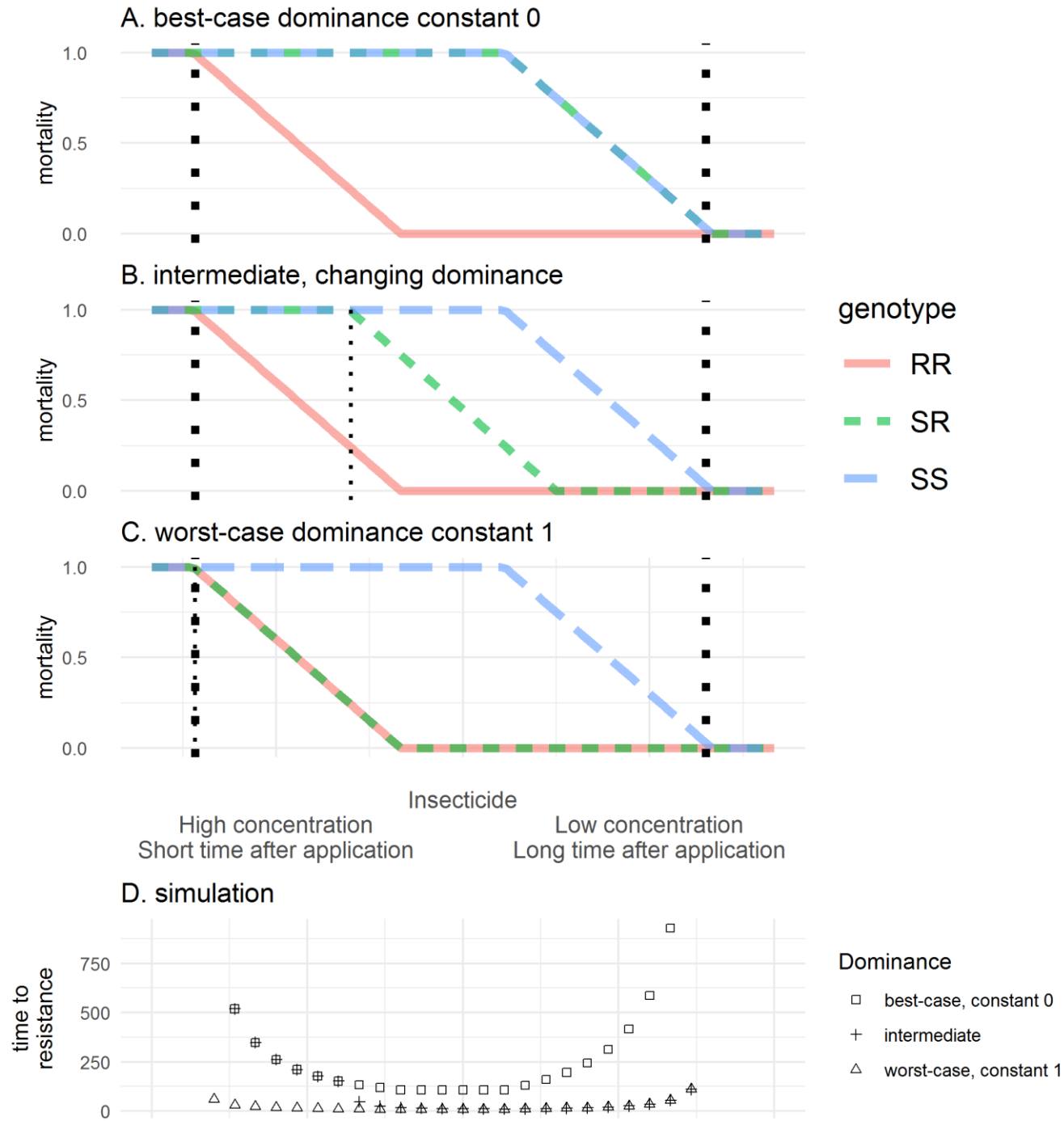
Data from : Georghiou, G. P. and Taylor, C. E. (1986) 'Factors influencing the evolution of resistance', in *Pesticide Resistance. Strategies and Tactics for Management.* Washington D.C.: National Academy Press, pp. 157–169.

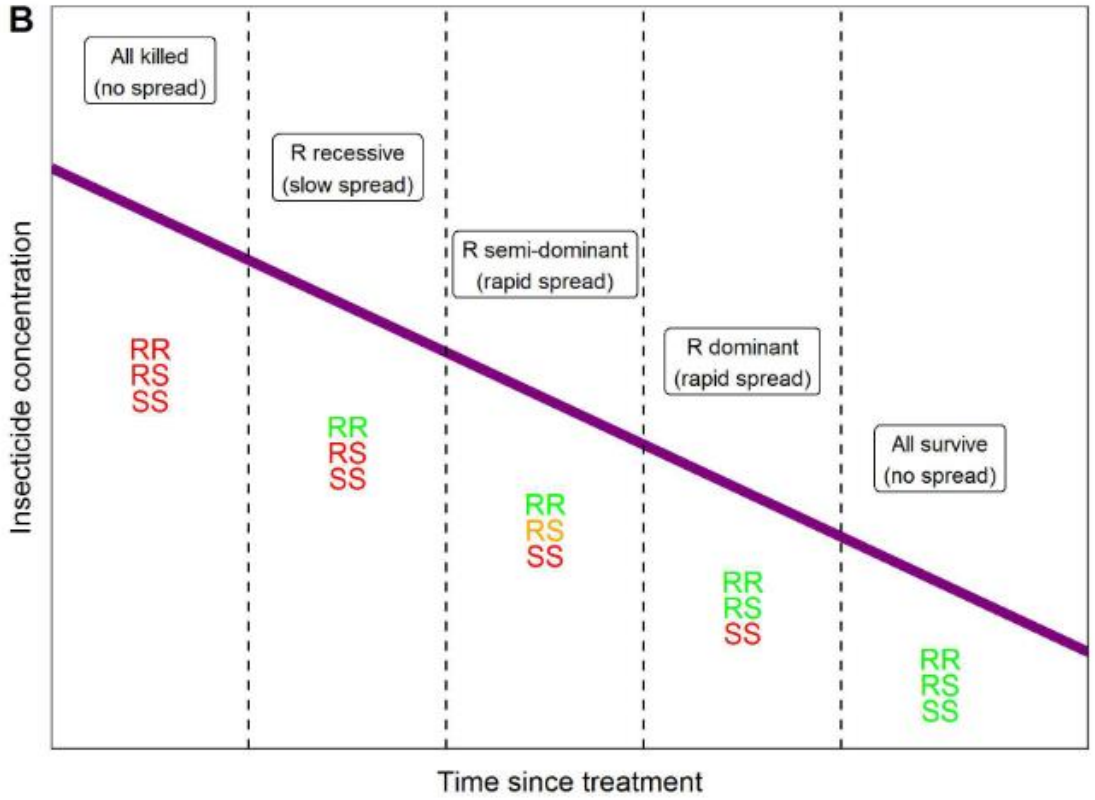
Discussion points

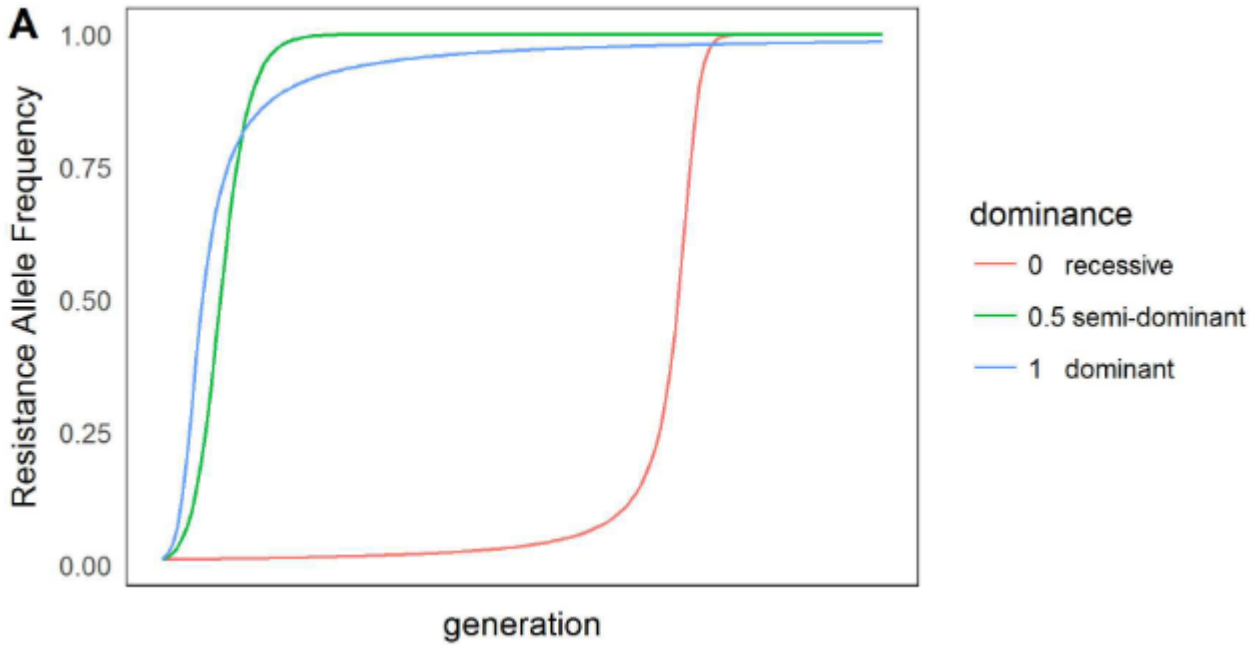
- Windows of selection can last months and years
  (less of an issue in agriculture where insecticides generally short lasting)

- Evolution of insecticide resistance likely greatest when
  mortality of partially resistant < susceptible

- Measurement of changing mortalities of RR, SR, SS genotypes over time
  needed to address implementation questions


A. best-case dominance constant 0
B. intermediate, changing dominance
C. worst-case dominance constant 1
mortality
1.0
0.5
0.0
Insecticide
High concentration
Short time after application
Low concentration
Long time after application
genotype
RR
SR
SS
D. simulation
time to resistance
750
500
250
0
Dominance
best-case, constant 0
intermediate
worst-case, constant 1





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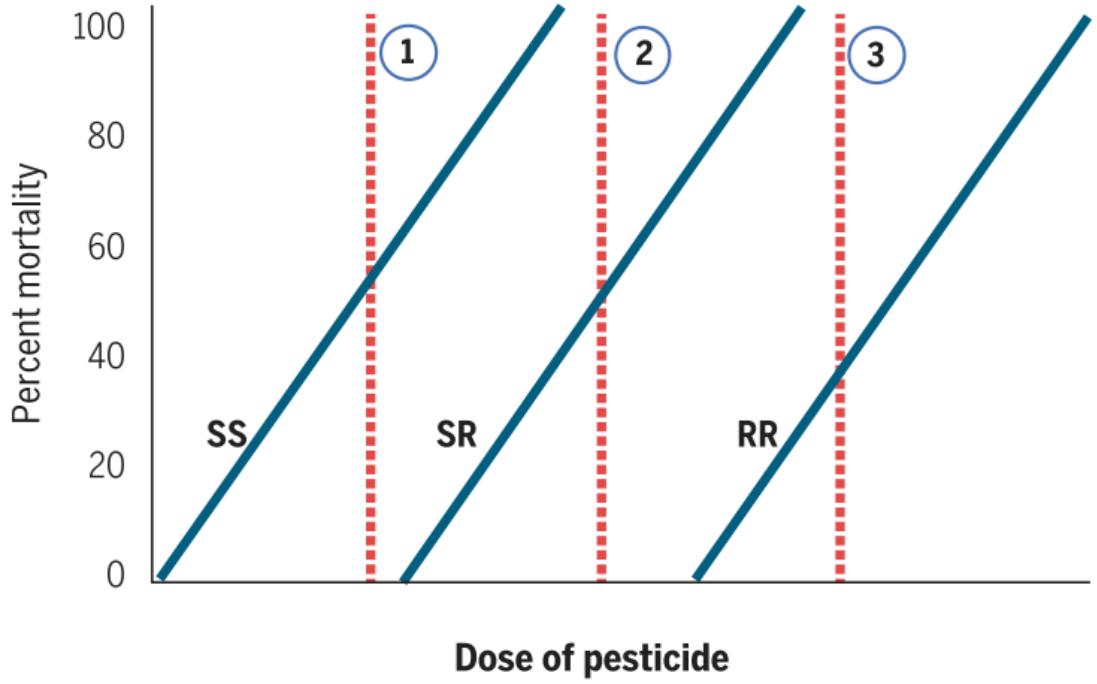

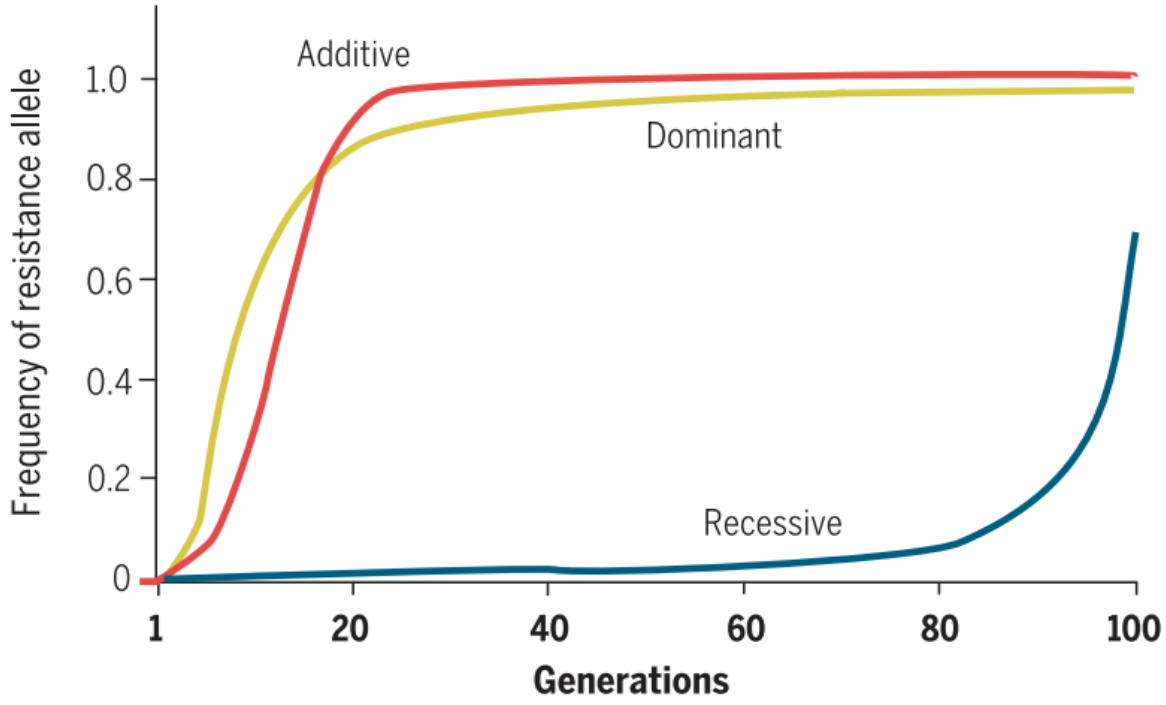

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