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 post-deployment 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. This makes it more beneficial for resistant insects to remain heterozygous.

Keywords
dose-response, drug resistance, insecticide resistance, insecticide resistance management, malaria, vector-borne diseases
Laboratory experiments - concentration

*Anopheles gambiae* exposed to deltamethrin

![Graph showing mortality percentage over concentration and time for resistant and susceptible strains of *Anopheles gambiae* exposed to deltamethrin.]
Laboratory experiments - time

- cement
- mud
- wood

strains:
- An. gambiae
- An. funestus
- A. aegypti

mortality % 24hrs vs. months after spraying deltamethrin

- resistant
- susceptible
Window of selection

- Genotype: resistant (rr) and susceptible (ss)

- Mortality

- High concentration (Short time after application)
- Low concentration (Long time after application)
Window of dominance — mortality of partially resistant lower than susceptible
Window of dominance for *Culex quinquefasciatus* larvae exposed to permethrin.

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