Insights from Molecular Effusion As An Analogy To Psyllid Entry Through A Breach In A Protective Structure

Tom Delfino

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Disclaimer

This presentation includes an equation for estimating the probability of a psyllid entering a protective structure through a breach. U.S. Dept. of Agriculture has not accepted this equation, or the approach used to derive it. If your protective structure is in the United States, do not attempt to use this equation to persuade USDA or your state agriculture agency that there is a low probability that a psyllid entered while a breach was open.

Key Factors

- **Size of the breach**
- **Length of time the breach was open (during daylight hours)**
- **Number of psyllids (psyllid density) in the vicinity**

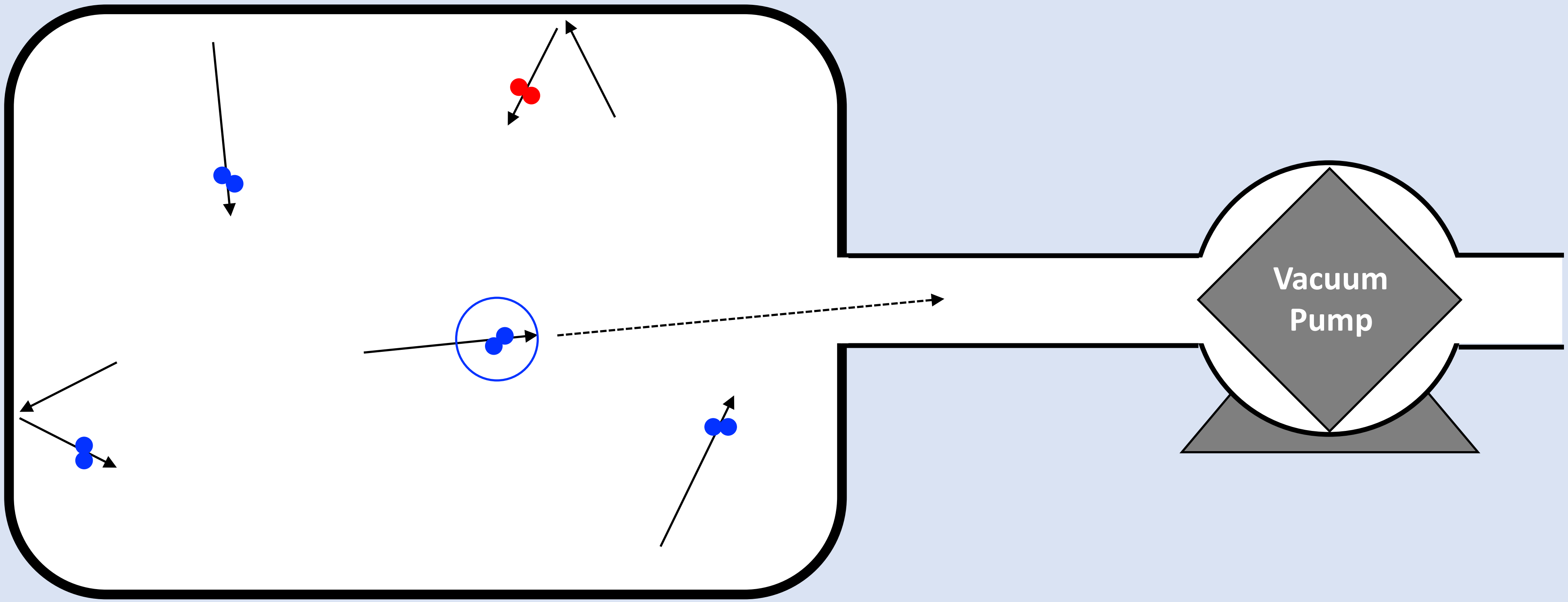
So, how to combine this information to estimate a probability that at least one psyllid entered through the breach?

By Analogy To Molecular Effusion

- **Molecular Effusion**
  - **Viscous flow of gases vs. molecular effusion – vacuum cleaner vs. vacuum pump**
  - **Molecular effusion – the mechanism:**

When gas molecules are rare and the opening small, molecular effusion is the mode of flow.

When psyllids are rare and the breach relatively small, psyllids entering the breach is analogous to molecular effusion.



The Probability

$$P_{\geq 1\ breach} = 1 - e^{\left(\ln\left(P_{=0\ trap}\right)\frac{A_{e\ breach}\Delta t_{day\ breach}}{\sum_{i=1}^{n}\left(A_{e\ trap_i}\Delta t_{day\ trap_i}\right)}\right)}$$

THIS EQUATION ONLY APPLIES WHEN <u>NO PSYLLIDS</u> HAVE BEEN TRAPPED.

$A_{e\ breach}$ is the effective area of the breach

$\Delta t_{day\ breach}$ is the amount of time during daylight hours that the breach was open

$A_{e\ trap_i}$ is the effective area of the i^{th} trap

$\Delta t_{day\ trap_i}$ is the amount of time during daylight hours that the i^{th} trap was posted

$$\sum_{i=1}^{n}\left(A_{e\ trap_i}\Delta t_{day\ trap_i}\right) = A_{e\ trap_1}\Delta t_{day\ trap_1} + A_{e\ trap_2}\Delta t_{day\ trap_2} + A_{e\ trap_3}\Delta t_{day\ trap_3} + \cdots + A_{e\ trap_n}\Delta t_{day\ trap_n}$$

Convert The Equation To A Decision Rule:

Rearranging the previous equation:

$$\frac{\ln(1 - P_{\geq 1\ breach})}{\ln(P_{=0\ trap})} > \frac{A_{e\ breach}\Delta t_{day\ breach}}{\sum_{i=1}^{n}(A_{e\ trap_i}\Delta t_{day\ trap_i})}$$

If this equation were

Values on this side are

If the right side is less than the left side, the risk of psyllid entry is acceptably low.

would specify values for $P_{\geq 1\ breach}$ and $P_{=0\ trap}$.

You (*mostly*) Control The Right Side

$$\frac{A_{e\ breach}\Delta t_{day\ breach}}{\sum_{i=1}^{n}\left(A_{e\ trap_i}\Delta t_{day\ trap_i}\right)}$$

Some Insights:

- **Design protective structures and their covering systems to minimize the size of a breach if one occurs.**
- **Cover a breach as fast as possible, preferably before sunrise.**
- **Place a lot of traps around the protective structure(s).**
- **Use the most attractive traps available.**
- **Post the traps in the most advantageous locations.**

Thank You