SCUDEM   Southern Arkansas University   Files

Jayla Myers, Patrick Hoover, Cameron Sorenson

Zachariah Hurdle

Problem chosen: C, Chemical Espionage

The problem that my group has decided to face and understand is Chemical Espionage. In this problem, there is a set of butterflies scientifically named *Pieris brassicae.* During their mating process, they attract wasps that will kill any offspring that the butterfly has. It is our job to predict the right amount of hormones the butterflies need to produce in order to increase the likelihood of hatching eggs while decreasing the likelihood of wasps killing any fertilized eggs.

The system of mating and wasp attraction isn't just as simple as producing hormones and killing butterfly babies. What starts the process is the female butterfly releases hormones in order to attract a mate. After a mate is found, the male butterfly releases another hormone called an anti-aphrodisiac. This anti-aphrodisiac sends a signal to other potential mates that the female has already gotten one, allowing the female to have more time to lay eggs. The anti-aphrodisiac also helps fertilize the eggs the female produces. One drawback is, when the anti-aphrodisiac is mixed with hormone from the female it attracts two different species of wasps. If the wasps detect this completed mixture, they will attach themselves to the butterflies and lay their eggs next to the butterfly eggs. When the wasp larvae hatch, they eat the butterfly eggs. This is the process in which we are trying to predict.

My group has modeled an equation of $n = 0.4(2g) + 2x - 0.5(N_0)$ to represent the number of butterflies that survive. In this equation, g is the number of egg clusters that hatch because of a male who uses an anti-aphrodisiac, and x is the number of egg clusters that hatch from males who do not use an anti-aphrodisiac. We have modeled the number of egg clusters that survive from males that use anti-aphrodisiacs as 0.4(2g). Each year, these butterflies have two mating seasons called a brooding season. This is modeled by the 2g. The likelihood of a butterfly surviving is lower when the males use the anti-aphrodisiac which is modeled by the 0.4. When the male does not use the anti-aphrodisiac, the likelihood of the eggs being eaten by wasp larva is reduced to zero. Therefore, all of the eggs that are fertilized hatch. The last variable, - 0.5(N_0), is to represent the number of butterflies that die between each breeding session.

If we assume the model as true, the predicted outcome will be that all males will stop using anti-aphrodisiacs. Since there is a lower mortality rate of butterflies that are fertilized by males that do not use anti-aphrodisiacs, more butterflies from this group will survive. As time passes, the males that use anti-aphrodisiacs will end up killing more of their offspring because of the wasps. Based on our model of the population, the butterflies genetically related to males who do not use anti-aphrodisiacs will become prevalent and will eventually become the entire population.

However, like any good prediction, there is the likelihood of bias. While our model is based on facts, there are a few assumptions that we made. One such assumption is the fact that the amount of anti-aphrodisiac used is based on genetics. We have also created a formula that only represents two set amounts of anti-aphrodisiac each male will use, one being enough to attract the two wasp species, and the other being males who do not use the hormone at all. In reality, the amount of anti-aphrodisiac will change based on each individual. We are also not including information on the males that use such an extreme amount of anti-aphrodisiac that the wasps are no longer attracted. While we do not include this information, we have done the best we could provided such a short time span.

References page

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