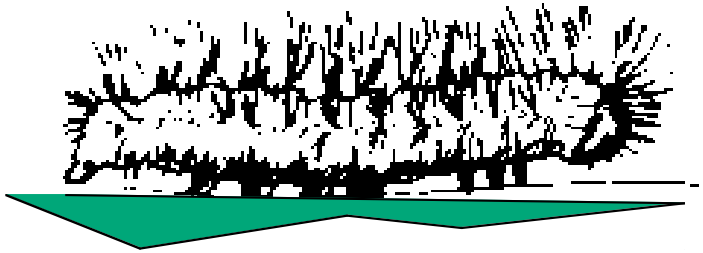
EVOLUTION OF DECEIT AS A SECOND-LINE DEFENSE:

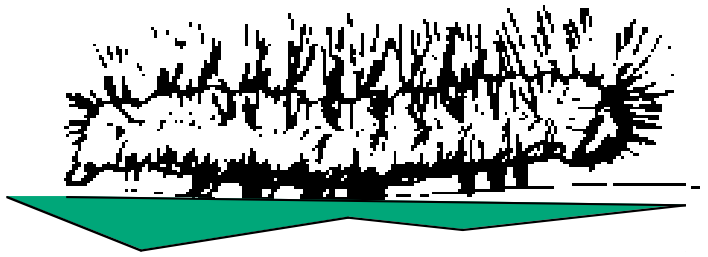
$$H_{t+1} = H_t e^{r-aPt}$$

$$P_{t+1} = H_t(1-e^{-aPt})$$



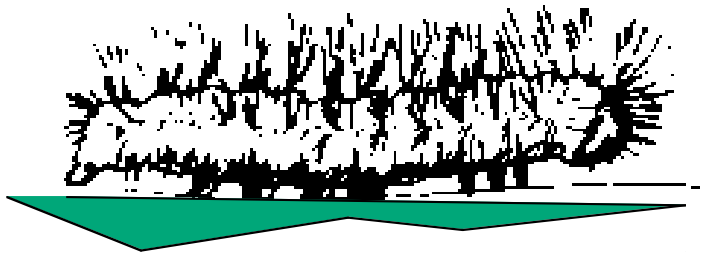
A QUESTION POSED:

Could a mutant fake marker invade of population of “honest” caterpillars?

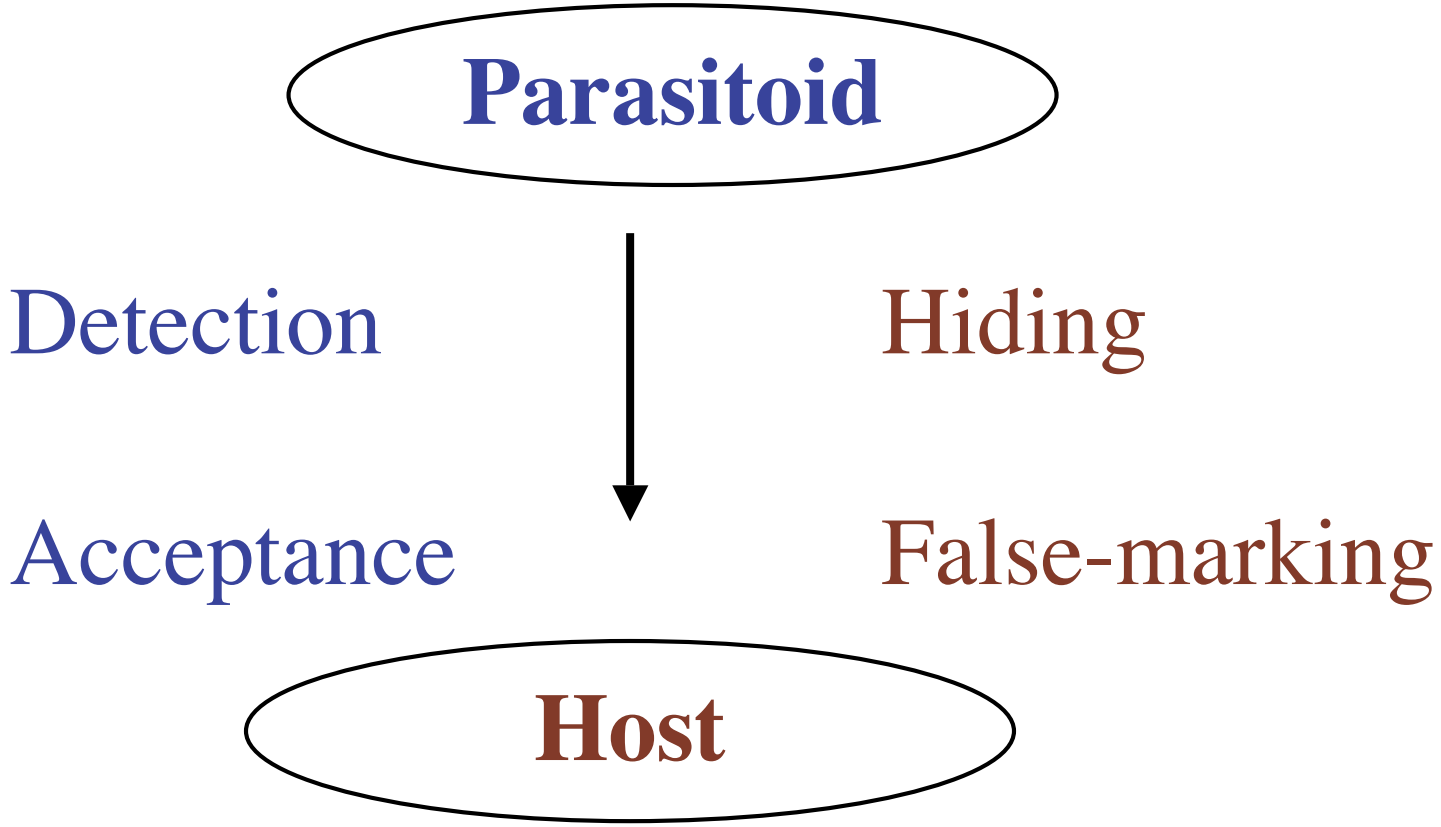


REFINE QUESTION

Could a mutant fake marker invade of population of “honest” caterpillars that employ hiding as a first line of defense?



SCENARIO


Parasitoid
Detection
Hiding
Acceptance
False-marking
Host

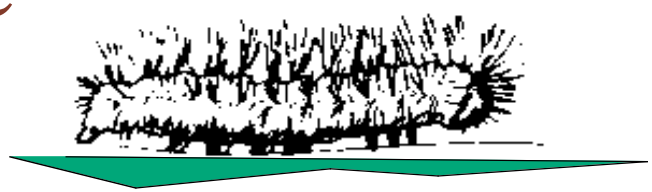
THE CHROMOSOME:
2 loci, 4 alleles

Hide

- High
- Medium
- Low
- No

False Mark

- Strong
- Medium
- Weak
- None



THE CHROMOSOME

A binary string that represents the phenotype that expresses a specific strategy:

e.g. 1 1 0 0

1 1 translates into good hider

0 0 translates into no mark

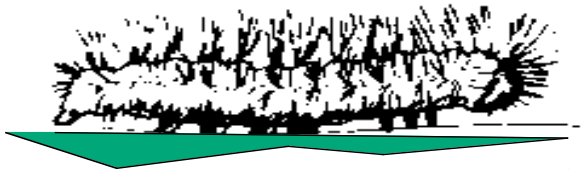
AN EXAMPLE

- Strategy 0010 has a value of 2
  i.e. 0*1 + 1*2 + 0*4 + 0*8

- Strategy 1001 has a value of 9 i.e.
  1*1 + 0*2 + 0*4 + 1*8

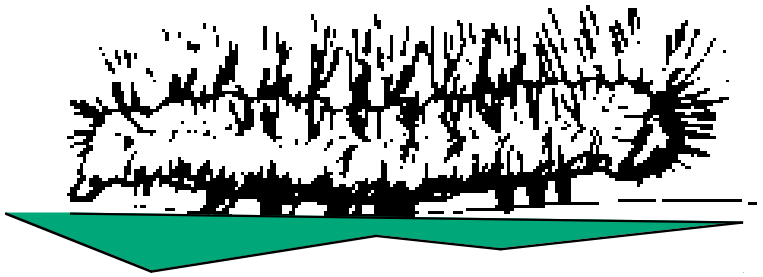
SIMULATION

- Deterministic
- Some proportion of hosts are found based upon relative hiding value
- Some proportion of found hosts are attacked based upon mark strength and wasp rules



UNLIKE PREY-

Hosts don’t disappear after attack but they may change identity



FITNESS IS DETERMINED BY:

- Escape from parasitoids
- Cost of defense

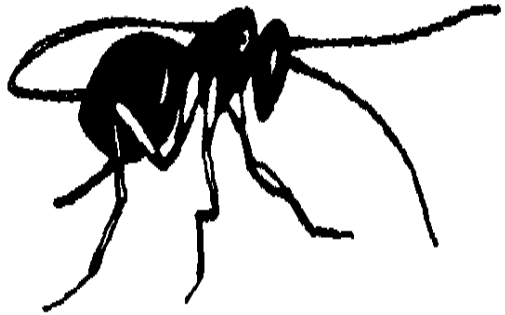
  Hiding≥ false-mark

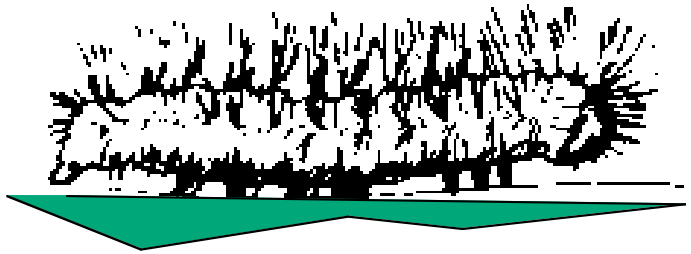
THREE SCENARIOS:

Parasitoids are hard wired (frequency independent)

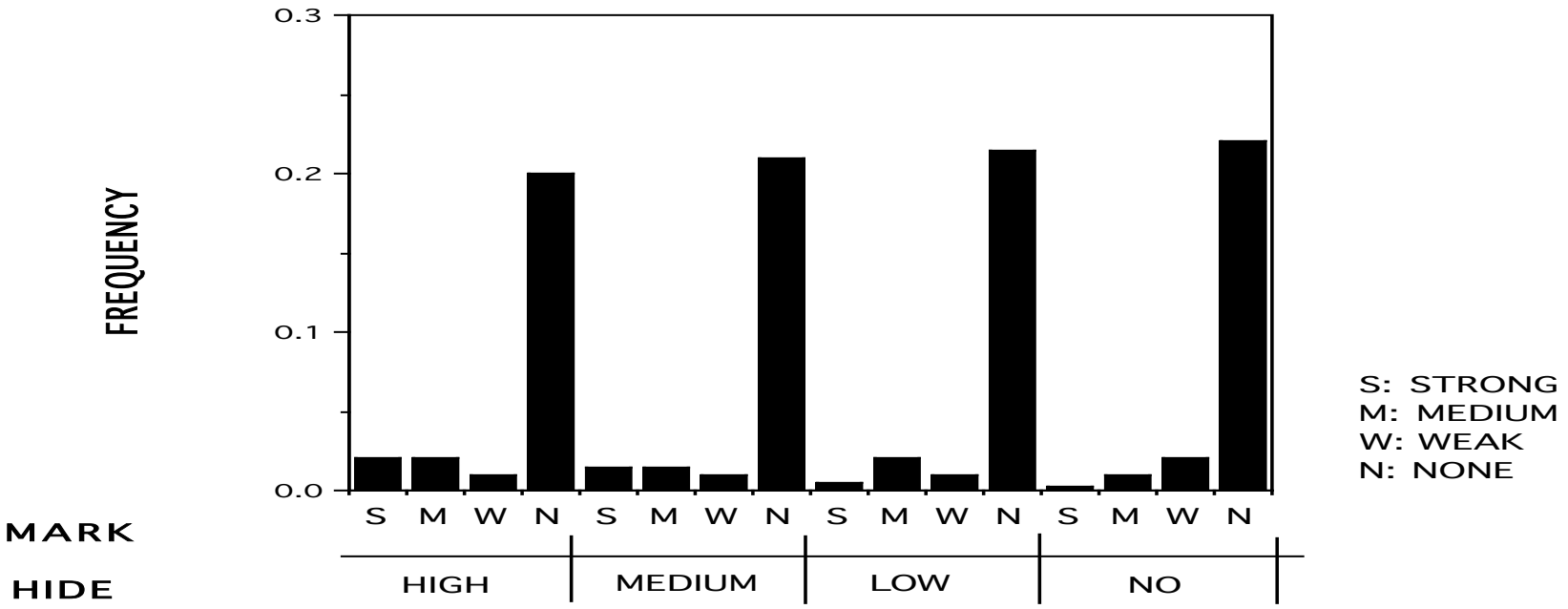
Parasitoids are flexible

Parasitoid's flexibility evolves

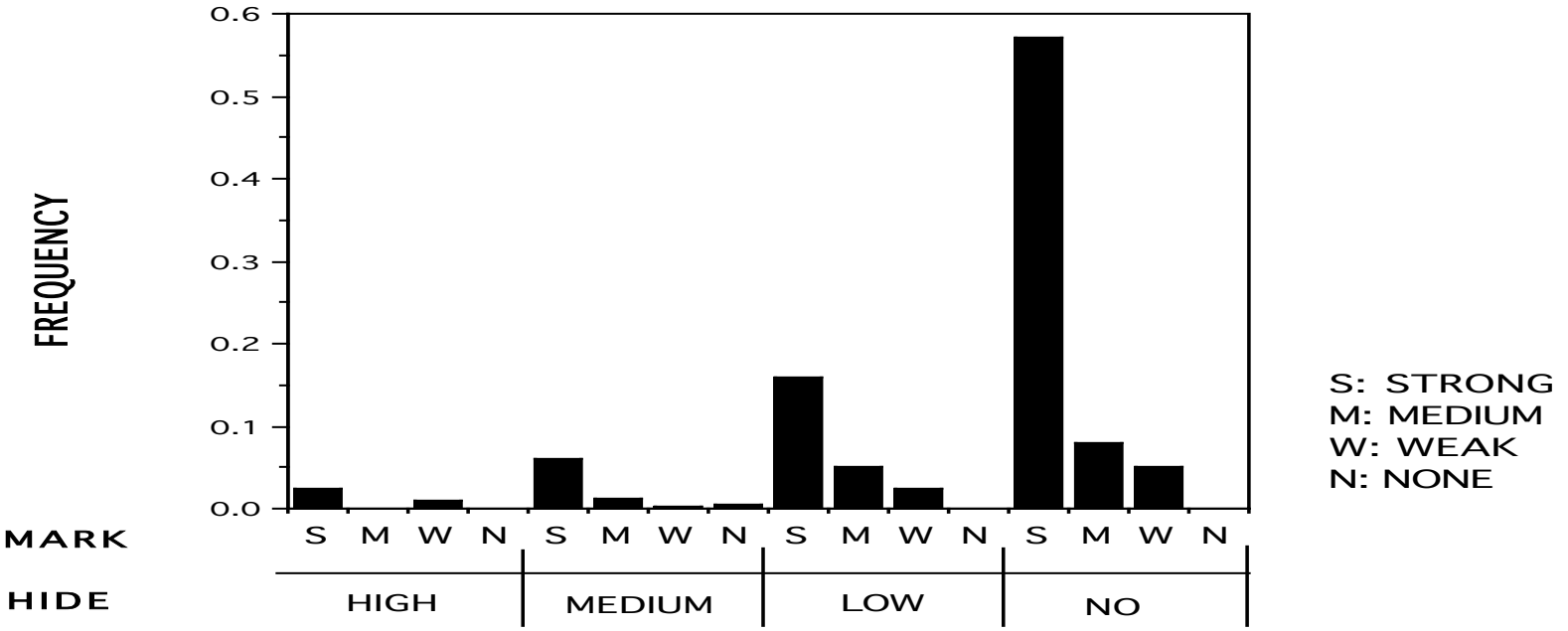




STARTING POPULATION

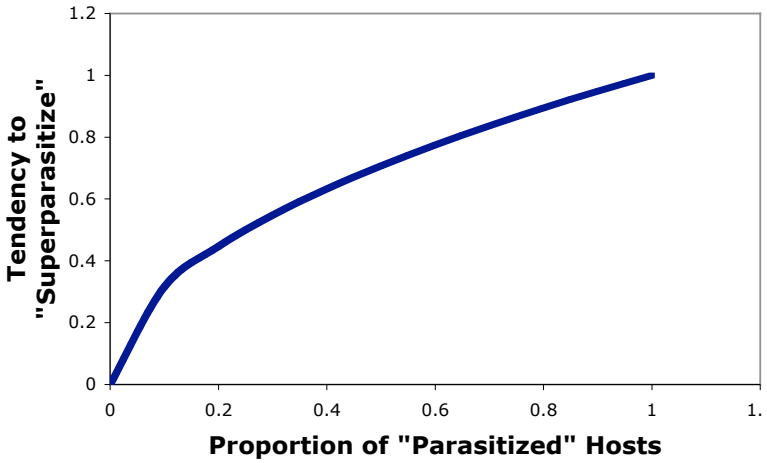


FREQUENCY INDEPENDENT

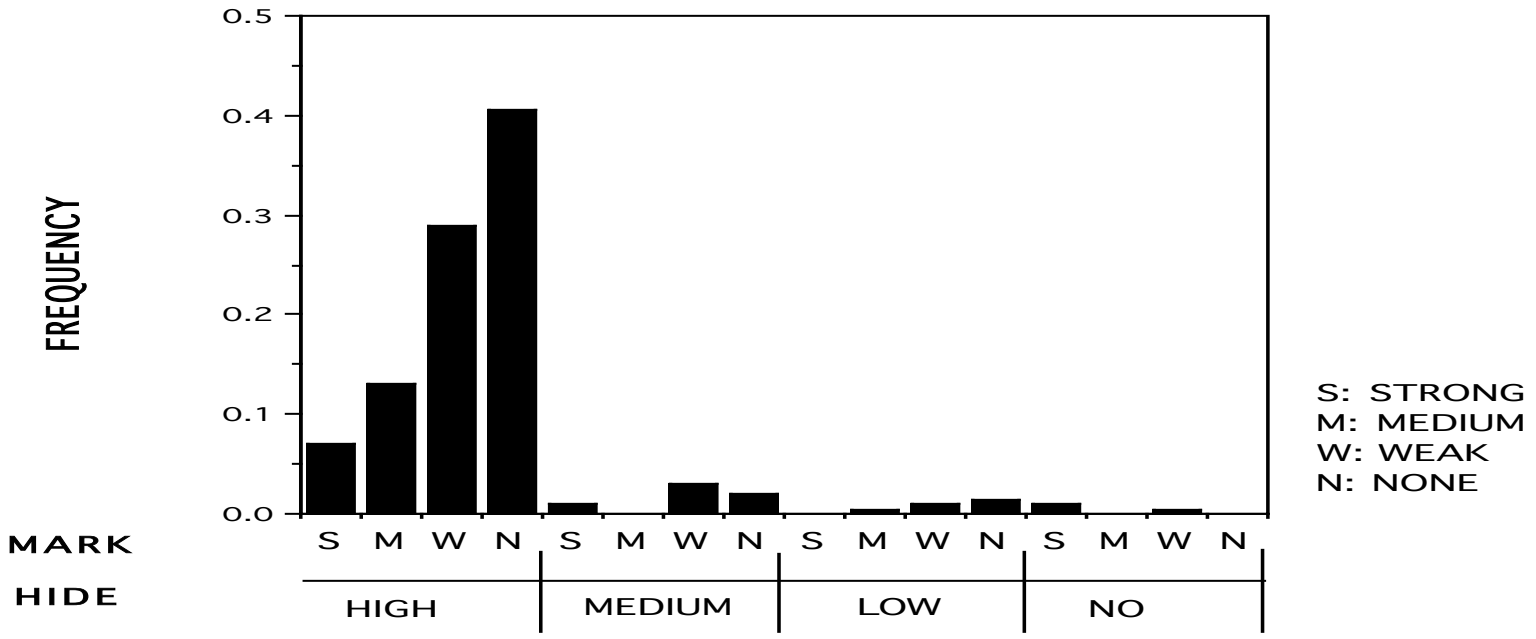


PARASITOID ACCEPTANCE PLASTICITY

- Within generation as number of "parasitized" hosts increases
- Among generations as fake marker phenotypes change in frequency

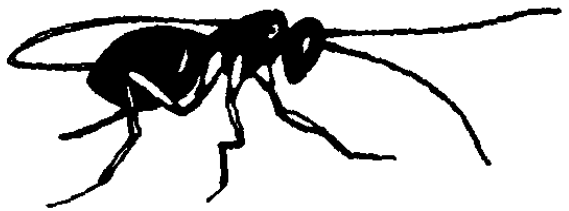


PLASTIC PARASITES



THE NEW GA

- Actually two GA's, one for the host population and one for the parasitoid population
- The parasitoid chromosome has one gene for sensitivity to mark strength and another for sensitivity to mark frequency in the environment



PARASITES EVOLVE

$$FIT(p) = \frac{a\left(Hf_h + \sum_{n=1}^{N} Ff_h o_{p,n} + Df_d o_{p,d} \right)}{1 + a\left(\frac{H}{t_o} + \frac{\sum_{n=1}^{N} Fo_{p,n}}{t_o} + \frac{\sum_{n=1}^{N} F(1 - o_{p,n})}{t_r} + \frac{\sum_{n=1}^{N} Do_{p,d}}{t_o} + \frac{\sum_{n=1}^{N} D(1 - o_{p,d})}{t_r} \right)}$$

PARASITOID'S PAYOFF

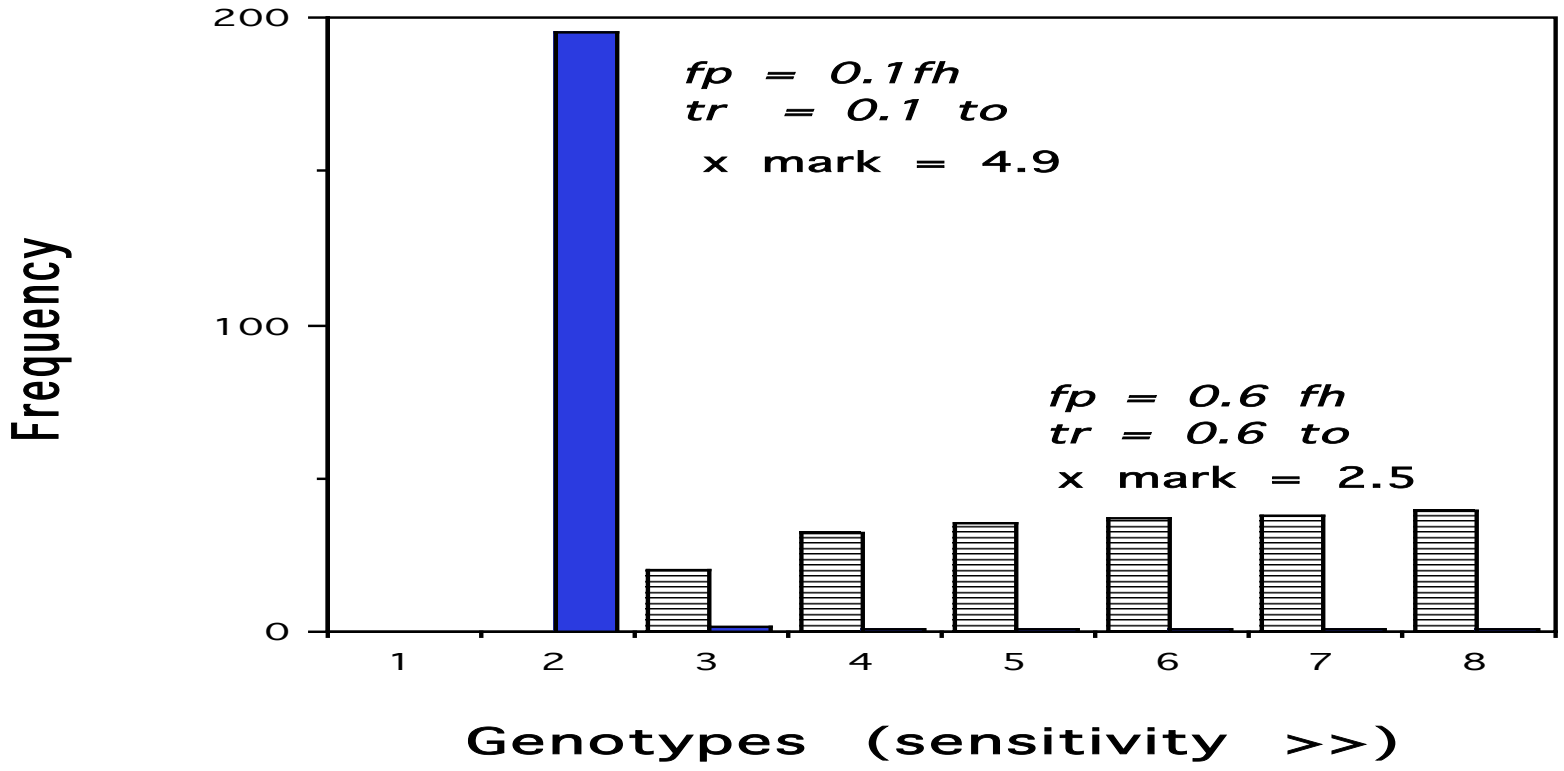
ACCEPT

- $FIT(a \mid p) = \mathit{f}p - t_o$
- $FIT(a \mid h) = \mathit{f}h - t_o$

REJECT

- $FIT = -t_r$

PARASITES EVOLVE



AN INSIGHT

False marking as a second line of defense only spreads through the prey population under limited circumstances

(our test is conservative!)

HOST DYNAMICS

$$\gamma_n(t+1) = \gamma_n(t)(1-\mu)$$

$$where\ \mu = \gamma_n \alpha_n \frac{1}{\sum_{n=1}^{N} \gamma_n \alpha_T} \rho\left(\frac{m}{T}\beta_n, \sigma\right)\theta$$

$where\ \alpha_n$ = hide genotype n,

$\frac{m}{T}$ = fraction of marked hosts in population T,

β_n = false - mark genotype n,

ρ = parasitoid response

σ = parasitoid response shape pararameter

θ = proportion of hosts encountered per epoch