

1. Suppose the population mates randomly, and then breaks up into smaller interacting groups.

2. Let there be two kinds of individuals:

A—Altruists, which perform acts at cost c to themselves, and benefit b to the recipient, where p is the probability of the benefit.

and

a—non-altruists

3. If W_0 is the baseline fitness, then

The fitness of the altruist is: $W_A = W_0 - c + p b$

And the fitness of the non-altruist is: $W_a = W_0 + p b$

Altruism spreads if $W_A > W_a$, which is when $c < 0$ (which means the act is not costly)

Suppose from the previous page, we have

$$W_0 = 2, b = 2, c = 1.$$

We get

	Partner	Defect	Cooperate
<u>Payoff to</u>			
Defect		$W_0=2$	$W_0+b=4$
Cooperate		$W_0-c=1$	$W_0+b-c=3$

Clearly the only ESS is to Defect. But, both would do better if they both cooperated. This is the PRISONER'S DELIMMA.

Relaxing the assumptions.

Natural selection would take the population to 100% defect, if the animals interacted only once, but what if the game is repeated many times.

The ESS is tit-for-tat (TFT)

- a) cooperate on the first move
- b) then repeat what ever your partner does on your next move.

For 10 trials, we get:

	Partner	Defect	TFT
<u>Payoff to</u>			
Defect		_____	_____
TFT		_____	_____

HENCE IN REPEATED CONTESTS, CONDITIONAL COOPERATION (TFT) CAN BE AN ESS.

4. Suppose groups are not assembled at random. Suppose they can interact with close relatives.

Let p = the probability that our target individual feels cooperative, and p^* is the probability in the resident population.

And

r = the relatedness among individuals

b = benefit of cooperative act to recipient

$k = (1-c)$ the fraction of fitness remaining to cooperative actor, where c is the cost of the act

ACTOR

RECIPIENT

$p k$ $(1 - p)$ $r p b$ $(1-r) b p^*$

$W = p k + (1-p) + r p b$

Cooperative allele will spread when

$$\frac{\partial W}{\partial p} > 0, \text{ which is when } r b + k - 1 > 0.$$

Substituting $c = 1 - k$, we get HAMILTON'S RULE:

$$r b > c$$

Hamilton's rule: $r b > c$

Hamilton suggested that haplodiploidy would favor the evolution of sterile castes, because females are more related to their sisters ($r = \frac{3}{4}$) than they are to their own offspring.

But he did not claim that haplodiploidy (haploid males and diploid females) was either necessary or sufficient for the evolution of sterile castes (eusociality)