

Evolution of Sociality



Outline

altruism vs. selfish behavior

inclusive fitness

Hamilton's equation

kin selection

traits which increase fitness spread rapidly by selection

traits which decrease fitness should be eliminated by selection

obligate siblicide in the Nazca booby



		effect on actor	
		-	+
effect on recipient	+	altruism	cooperation
	-	spite	selfish

how do altruistic traits evolve ?

Benefit > Cost

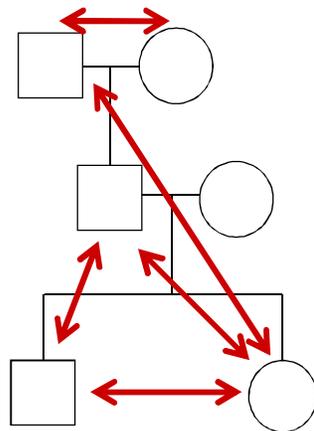
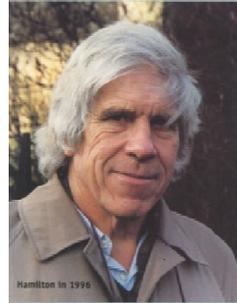
$$b > c$$

WD Hamilton 1964

$$r b > c$$

↖ degree of relatedness

the quantity of "your" genes that are in someone else



What is fraction of genes in common among relatives?

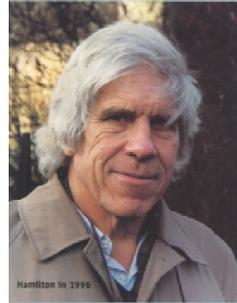
Benefit > Cost

$$b > c$$

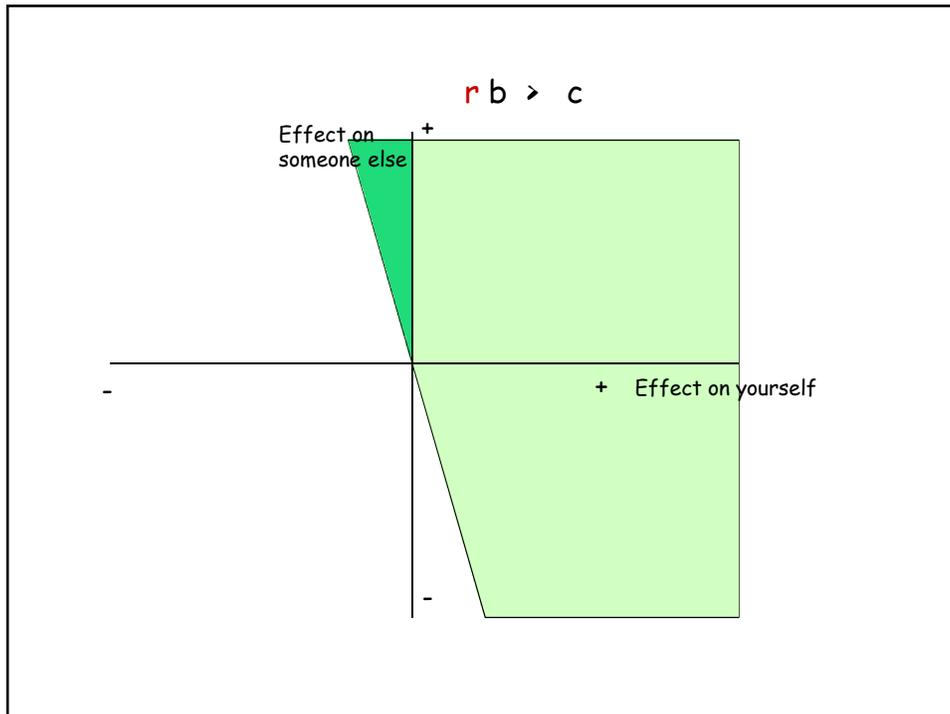
WD Hamilton 1964

$$r b > c$$

↖ degree of relatedness



Inclusive Fitness = Direct Fitness + Indirect Fitness
your offspring offspring of kin



Helping behavior

instead of dispersing, adult young remain at home and help rear siblings (guard young, bring back food)

defer reproduction for ≥ 1 years

several species of birds, a few species of mammals

usually arises from ecological constraints

helping behavior may benefit helpers
increased probability of becoming a breeder
improved parenting ability
increased inclusive fitness (raise siblings)

predictions:

discrimination between close and more distant kin
significant indirect fitness

Pied Kingfishers

One group are offspring of previous mating
primary helpers $r = 0.32$

Another group isn't
secondary helpers $r = 0$



	Year 1	Year 2	Total
	young x r = f_1	offspring x r x survival x mating = f_2	$f_1 + f_2$
Primary	$1.8 \times 0.32 = 0.58$	$2.5 \times 0.5 \times 0.54 \times 0.6 = 0.41$	0.99
Secondary	$1.3 \times 0 = 0$	$2.5 \times 0.5 \times 0.74 \times 0.91 = 0.84$	0.84

Direct + Indirect = Inclusive Fitness

$$D + rB$$

Kin selection and the evolution of cooperative breeding



Kin selection and the evolution of cooperative breeding

does kin selection really drive helping behavior?

relatively few studies look at kin discrimination and the effect of 'helping.'

Combine studies with a meta-analysis of species with adult helpers: 15 birds, 3 mammals

Zr - kin = correlation between probability/amount of help and genetic relatedness [**Do they help kin?**]

Zr - help = correlation between amount of help and benefit of help (offspring production/survival) [**Does it matter?**]

Griffin and West 2003 Science 302:634

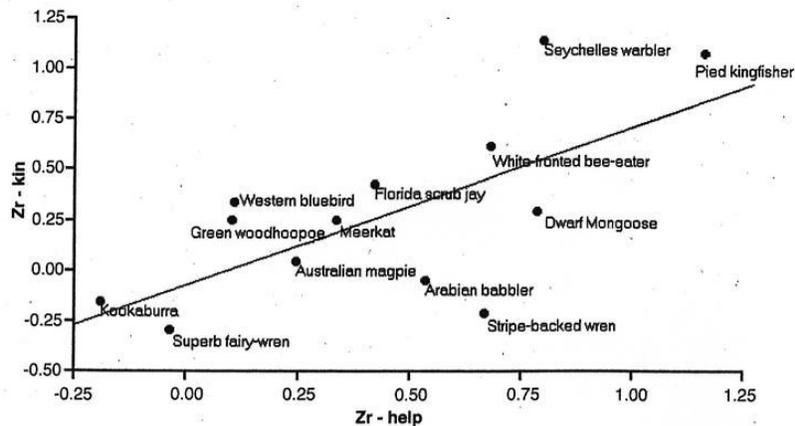
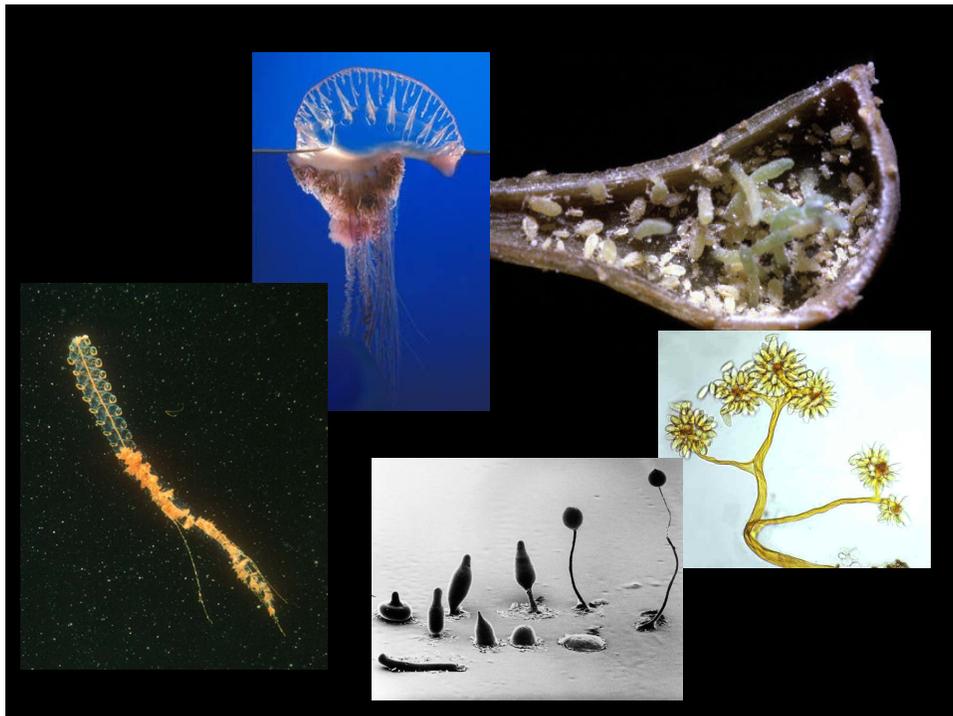


Fig. 2. Correlation between kin discrimination and the benefits of helping. The effect size of the relationship between level of help and relatedness (Z_r transformation of r_{kin}) is plotted against the effect size of the relationship between the benefit of helping and the level of helping (Z_r transformation of r_{help}). The significant positive relationship between these two variables ($P = 0.01$) indicates that preferential helping of relatives (kin discrimination) is more likely in species where there are greater fitness benefits from helping, as predicted by kin selection theory.

Where should we see the greatest altruism?

Where we see the highest relatedness.



Social Hymenoptera



Termites



Naked Mole Rats



an individual's alleles are transmitted to the next generation directly via its personal reproduction and indirectly via reproduction by relatives

inclusive fitness is the sum of the direct and indirect components of fitness

natural selection acts to increase the genetic contribution to the next generation, but the contribution can be both direct and indirect

altruistic traits are costly to the actor, beneficial to the recipient