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T.Y.B.Sc
Paper IV – Animal Behaviour
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Kin Selection

1. An **altruistic** behavior is one in which an individual (the donor) performs an action that helps another animal (the recipient) with no apparent advantage to itself.
2. **Kin selection** is the evolutionary altruism that selects for those behaviors that increase the inclusive fitness of the donor. However, suppose that altruists are discriminating in who they share food with. They do not share with just anybody, but only with their relatives. Relatives are genetically similar and they share genes with one another.
3. So when an organism carrying the altruistic gene shares his food, there is a certain probability that the recipients of the food will also carry copies of that gene. The gene causes an organism to behave in a way which reduces its own fitness but boosts the fitness of its relatives. Now these relatives have a greater chance of carrying gene to next generation. So the overall effect of the behaviour may be to increase the number of copies of the altruistic gene found in the next generation.
4. This means that the altruistic gene can in principle spread by natural selection. Such altruism seems anomalous from the individual organism's point of view, but from the gene's point of view it makes good sense.
5. Individuals with whom an individual is closely related share genes including genes that code for cooperative behavior.

Hamilton's rule:

Though this argument was hinted at by Haldane in the 1930s, it was first made explicit by William Hamilton (1964). Hamilton demonstrated rigorously that an altruistic gene will be favored by natural selection when a certain condition, known as *Hamilton's rule*, is satisfied. In its simplest version, the rule states that:

$$B > C/r$$

<u>Or</u>

$$Br - C > 0$$

where C is the cost incurred by the altruist (the donor), B is the benefit received by the recipients of the altruism, and r is the *co-efficient of relationship* between donor and recipient.

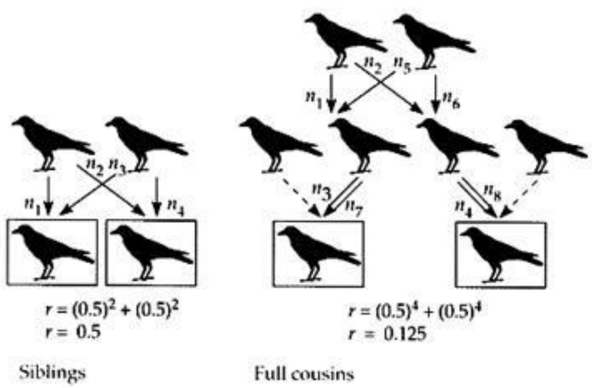
The **coefficient of relatedness (*r*)** between two individuals is defined as the percentage of genes that those two individuals share by common descent. That may seem a little complicated, but it is actually easier to calculate than to define. Consider the simplest example of calculating the coefficient of relatedness of a parent and its offspring in a diploid system. The offspring inherit 1/2 of their genome from a particular parent, so that they will have a coefficient of relatedness of 0.5. If you take this one generation further, the offspring's offspring (grandoffspring) will have 1/2 of the genome of its parent, and consequently 1/2*1/2=1/4 of its genome from its grandparent. Thus, a grandparent and grandoffspring have a coefficient of relatedness (*r*) of .25. In general *r* =$.5^n$ where n is the number of "generational links" (Campbell 1993). Some more examples are shown in the figures below.

Proportion of alleles shared ibd by full sibs

P: A1A2 x A3A4
O:

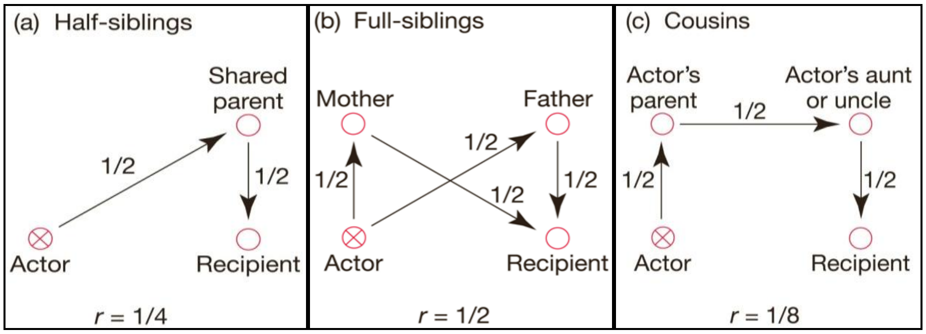
		Sib 1			
		A_1A_3	A_2A_3	A_1A_4	A_2A_4
Sib 2	A_1A_3	1.0	0.5	0.5	0
	A_2A_3	0.5	1.0	0	0.5
	A_1A_4	0.5	0	1.0	0.5
	A_2A_4	0	0.5	0.5	1.0

The average proportion of alleles shared ibd (identical by descent) by pairs of full sibs is 0.5

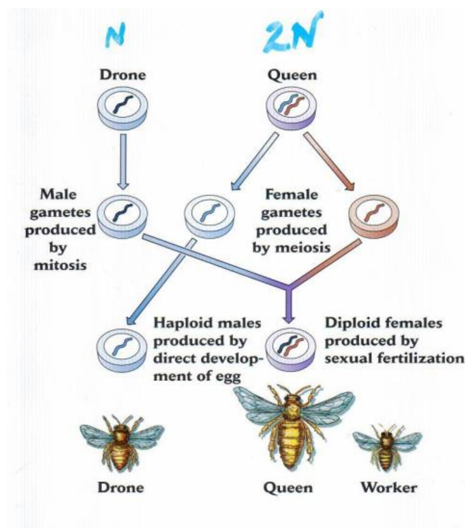


(you may not draw this fig.)

The costs and benefits are measured in terms of reproductive fitness. The co-efficient of relationship depends on the genealogical relation between donor and recipient — it is defined as the probability that donor and recipient share genes at a given locus that are 'identical by descent'. (Two genes are identical by descent if they are copies of a single gene in a shared ancestor.) In a sexually reproducing diploid species, the value of r for full siblings is ½ (b), for parents and offspring ½, for grandparents and grandoffspring ¼ (a), for full cousins $^1/_8$ (c), and so-on. The higher the value of r, the greater the probability that the recipient of the altruistic behaviour will also possess the gene for altruism.



Though Hamilton himself did not use the term, his idea quickly became known as 'kin selection'. Kin selection theory predicts that animals are more likely to behave altruistically towards their relatives than towards unrelated members of their species. For example, in various bird species, it has been found that 'helper' birds are much more likely to help relatives raise their young, than they are to help unrelated breeding pairs. Similarly, studies of Japanese macaques have shown that altruistic actions, such as defending others from attack, tend to be preferentially directed towards close kin. In most social insect species, a peculiarity of the genetic system known as 'haplodiploidy' means that females on average share more genes with their sisters than with their own offspring.



So a female may well be able to get more genes into the next generation by helping the queen reproduce, hence increasing the number of sisters she will have, rather than by having offspring of her own. Kin selection theory therefore provides a neat explanation of how sterility in the social insects may have evolved by Darwinian means.

Examples:

- A well known example of kin selection in operation is the study of alarm calls in squirrels by Paul Sherman (1977). In this study, Sherman studied the likelihood of males (who do not nest near genetic relatives) and females (who do nest near genetic relatives) to give alarm calls that warn others of predators while placing caller at a greater risk of attack. It turns out that males are less likely to give such calls than females, thus supporting the kin selection hypothesis.
- Social insects are an excellent example of organisms that display presumed kin selected traits. The workers of some species are sterile, a trait that would not occur if individual selection was the only

process at work. The relatedness coefficient *r* is abnormally high between the worker sisters in a colony of Hymenoptera due to haplodiploidy, and Hamilton's rule is presumed to be satisfied because the benefits in fitness for the workers are believed to exceed the costs in terms of lost reproductive opportunity, though this has never been demonstrated empirically.

- The most obvious form of kin selection is the caring of offspring by parents, i.e., it pays for parents to care for their offspring because their offspring share genes with them (that is, any allele that coded for not caring for otherwise helpless offspring would quickly go extinct).

Kin Selection May Play a Role

Another proposed mechanism for the evolutionary development of true altruism is kin selection. In evolutionary biology, *kin selection* refers to changes in gene frequency across generations that are driven at least in part by interactions between related individuals. The population geneticist, J. B. S. Haldane once remarked that, *"I'd gladly lay down my life for two brothers or eight first cousins."* Haldane's statement makes sense in that two brothers or eight first cousins (or four nephews) would pass on as many particular combinations of his genes to the next generation as he would himself.

Kin selection and reciprocity are demonstrated by the vampire bats mentioned earlier in that a significant percentage of the recipient bats are related to the donor. Another of many examples is seen in wild turkeys. Groups of males will gather in a special mating territory where with ritualized tail spreading, wing dragging, and gobbling, they attempt to entice female turkeys to mate.

Because of cooperation between males within a group, one group attains dominance over other groups, and its dominant member is the one that copulates most frequently with the females. Seemingly the males who helped establish the dominant group but who have low social status within the group gain nothing. However, close analysis has shown that all members of the dominant group are brothers from the same brood. Since they share many genes with the successful male, they are indirectly perpetuating many of their own genes.

Humans may be the only species that perform acts of altruism which are on a higher plane than any other. Even though creatures as lowly as slime molds and everything in-between seem to exhibit some form of altruistic behavior, humans seem to be the only animal capable or willing to help others to which they are not genetically related and may not even know.

Evolutionary biologists, ethologists, sociologists, and psychologists to present have not been able to provide definitive answers as the origin and development of this unique social behavior or as to what advantages such an adaptation might impart on individual animal or on species.