Kin value: relatedness, reproductive value, mating success

Aims
1. To show where regression relatedness, sex-specific reproductive value, and sex-specific mating success come from and how they affect the efficiency by which one organism can transmit another's genes.
2. To begin to show how to combine these three parameters to determine the value of one organism to another (kin value) and so to determine the interests of different colony members over colony reproduction.

Objectives
1. To understand in general terms what regression relatedness, sex-specific reproductive value, and sex-specific mating success mean and where they come from.
2. To understand how to combine regression relatedness, sex-specific reproductive value, and sex-specific mating success to determine kin value.

Part 2 of course
The opening series of lectures, which introduced the eusocial insects and provided background and introductory material in several areas of social insect biology, has now ended. The second part of the course, of which this is the first lecture, focuses on an area of biology in which social insects have made an important contribution. This is the use of inclusive fitness theory to investigate conflict and conflict resolution in social groups. This area brings together theory with experiment and data collection. The theory is often used to make predictions that can be tested by appropriate data. Although the theory is mathematical, the maths is not hard. Most things can be understood via simple algebra aided by diagrams. This area is one of the two major focuses of Professor Ratnieks's research and that of his laboratory at the University of Sussex.

The Big Picture
Within a colony there is typically a range of individuals that the workers can rear into reproductives: males versus females, brothers versus sons versus nephews, full sisters versus half sisters. Which of these should be reared? In the case of males versus females, in what ratio (sex ratio) should they be reared? Should workers stop each other producing males and concentrate on rearing the queen's sons? What is the interest of the queen? In general, natural selection will cause a worker to rear those individuals that are best at transmitting the worker's genes. These are the individuals with the greatest kin value. Kin value has three basic components: regression relatedness, sex-specific reproductive value, and sex-specific mating success.

Regression relatedness
Genetic relatedness can be a confusing topic. We often hear things like "chimps and humans share 99% of their genes". We also share genes with bacteria. Does that mean that we are 99% related to chimps, and 10% related to bacteria? The concept of relatedness as used in the study of social behaviour and evolution only considers relatedness among members of the same population. It is meaningless to talk about relatedness between chimps and humans, even though different species have genes in common.

Within the human population there are individuals of different relatedness to you. On average, your relatedness to other members of the human population is defined as 0, even though they are all humans and all have the same set of gene loci as you (though probably not the same alleles at these loci). Your relatedness to your mother and father, your son and daugher, and your full-brother and full-sister are 0.5. If you have an identical twin, or can arrange to have yourself cloned, then your relatedness to that person is 1.

These relatedness values come from the probability of sharing genes identical by descent. A solid basis for understanding relatedness can be obtained by considering the regression of one individual's genotype on another's. Some complications are introduced because male Hymenoptera are haploid and females are diploid. Work your way through the examples on the slides. You should first understand how the gradient of the gene score regression to a clonemate is 1. This is where a relatedness of 1 comes from. The average gene score gradient to randomly chosen individuals in the population is 0. This is where a relatedness of 0 comes from. From these simple examples you will be ready to understand relatedness to relatives. Finally, you will also be ready to understand why, in haplodiploids, the regression relatedness of a son to his mother is not the same as from a mother to her son.

It is not essential to work through all the examples in detail. What you must do is to get a general understanding of where regression relatedness is coming from. Relatedness is usually presented as a table in a book. It is also necessary to understand, in general terms, how these values are obtained.