RESEARCH

Kin recognition in social insects

In two very well known papers in 1964, W. D. Hamilton proposed a genetical theory for the evolution of altruistic and other social behaviour, a theory which is now known as kin selection. Hamilton's ideas were rapidly appreciated and widely applied (Wilson, 1971). Yet, at least for the next 15 years we had no clue as to how animals assessed kinship or genetic relatedness amongst themselves. This situation has now changed and the ability to discriminate kin from non-kin has been reported not only in ants, bees and wasps but also in marine invertebrates, isopods, fishes, frogs, toads, birds and a variety of mammalian species (Gadagkar, 1985).

The theory of kin selection is especially attractive for those of us working with social insects because the system of haplodiploidy, universal in the Hymenoptera, makes a female more closely related genetically to her full sister than to her daughter. This obviously makes kin selection more powerful but there is one catch. Many social Hymenopteran queens are known to mate, multiply and produce different patrilines of daughters. This means that the workers may have to rear half sisters as often or probably more often than they can rear full sisters. If workers had the ability to distinguish between their full and half sisters then of course they could give preferential treatment to their full sisters and bring back power to the force of kin selection. For this reason kin recognition and especially its mechanism are also of particular interest to those of us studying social Hymenoptera.

The first and perhaps still the most spectacular demonstration of kin recognition was that of Greenberg in the primitively eusocial sweat bee *Lasioglossum zephyrum*. This is a bee that lives in a system of burrows under the soil. One of the bees usually assumes the role of a guard and, sitting at the entrance to the burrow, prevents entry of both parasites as well as non nestmate conspecifics. Breeding these bees in artificial nests in the laboratory, Greenberg presented guard bees with unfamiliar intruders but whose genetic relatedness to the guard bees was known to him. Testing bees of 14 different geneological relationships against one another in this fashion, Greenberg showed that the probability of acceptance of an intruder depends on how closely the intruder is genetically related to the guard bee. Subsequent experiments suggest that the guard bees learn the odours of their nestmates and then using these learned odours as a guide, they accept or reject intruders depending on the similarity of the intruder's odour to those of the guard's nestmates (but apparently not depending on similarity to itself). This means that a bee will not be able to distinguish between its full and half sisters if it has lived with and learned the odours of both.

Apis mellifera is perhaps the most extensively investigated social insect as far as kin recognition goes. It is now well known that workers recognise queens as well as each other on the basis of genetic relatedness. Even more significant is the recent finding by a number of different investigators that honeybee workers are capable of giving differential treatment to their full and half sister larvae. It is now well known that there would be different patrilines within a honeybee hive because the queens mate with many drones and simultaneously use sperm from several of them to fertilise her eggs.

Ants have also been popular for studies on kin recognition. The acacia ant *Pseudomyrmex ferruginea* has been shown to use genetically determined recognition labels (probably pheromones)

produced by each individual ant. This is suggestive of an ability to discriminate between full and half sisters. *Camponotus* species appear to use a hierarchy of cues, the most dominant of which seems to be a substance produced by the queen and transferred to all the individuals of the colony. In this case too, there is evidence that workers can discriminate between their full and half sisters. In other genera such as *Odontomachus, Acromyrmex* and *Cataglyphis* their is an ability to discriminate nestmates from non nestmates but different levels of genetic relatedness within a colony cannot be discriminated. In *Cataglyphis* for instance, workers seem to use what they have learnt during their larval period for discrimination of nestmates during their adult life.

Paper wasp belonging to the genera *Polistes*, *Dolichovespula* and *Ropalidia* are also capable of nestmate discrimination. These wasps learn recognition odours from their nest (and probably nestmates) and also seem to acquire recognition labels at eclosion.

The mechanism of kin recognition or nestmate discrimination seen in different groups, presents somewhat of a paradox. The primitively eusocial insects such as the wasps and the sweat bees have a mechanism which does not allow discrimination of different patrilines while many highly social groups such as honeybees and some ants have a mechanism that permits such discrimination. From the point of view of kin selection however one might have expected the primitively eusocial insects to be able to discriminate full and half sisters and restore a powerful role for kin selection.

Further Readings :

1. Gadagkar, R. (1985) Kin recognition in social insects and other animals—A review of recent findings and a consideration of their relevance for the theory of kin selection. Proc. Indian Acad. Sci. (Anim. Sci.) **94** : 587-621.

2. Hamilton, W.D. (1964a) The genetical evolution of social behaviour I. J. Theor. Biol. **7** : 1-16.

3. Hamilton, W.D. (1964b) The genetical evolution of social behaviour II. J. Theor. Biol. **7** : 17-52.

4. Wilson, E.O. (1971) The insect societies. Harvard University Press, pp X + 541.

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