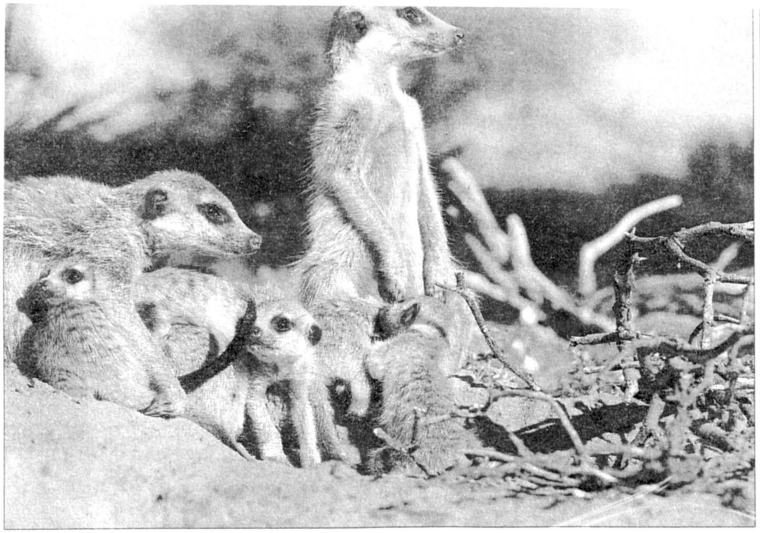

Genes will do whatever it takes to duplicate themselves and survive, even if the result is infanticide, murderous queens or a vicious battle of the sexes. ***Roger Highfield*** *examines new evidence that reinforces Richard Dawkins' 30-year-old vision of ruthless DNA*

Loveable rogue, or selfish killer?

"We are survival machines – robot vehicles blindly programmed to preserve the selfish molecules known as genes. This is a truth which still fills me with astonishment" – ***Richard Dawkins,*** **The Selfish Gene**

Three decades after Richard Dawkins revolutionised our understanding of living things with *The Selfish Gene*, evidence has accumulated to back his cold-eyed vision of how bodies, families and society are shaped by the simple "duplicate me" message in our genetic instructions.

His book, which has sold more than a million copies, did not mean to imply that genes have actual motives, only that their effects can be described as if they do: the genes that get passed on to the next generation are the ones whose consequences serve their own interests, not necessarily those of the societies or even the organisms in which they find themselves. We are merely vehicles to help replicate DNA, according to the Oxford University biologist.

A Cambridge University team reported the consequences for meerkats, those loveable stars of natural history films, a day or two before Prof Dawkins marked the 30th birthday of his book last week, with a packed Darwin@LSE event with Ian McEwan, Dan Dennett, Matt Ridley, Sir John Krebs and Melvyn Bragg at the London School of Economics.

A meerkat group is closely related and this is why they look out for each other. But the image of caring creatures standing on endless sentry duty to protect their pups and family does not quite tell the full story, according to an eight-year study carried out on the Kuruman River Reserve by Dr Andrew Young and Prof Tim Clutton-Brock.

In the case of guarding against predators, the "selfish" actions of genes lead to unselfish actions. But food is so scarce that the matriarch tries to monopolise reproduction in the group so only her genes are passed on. When she becomes pregnant she evicts subordinate females and kills their young to maintain control.

When her pups are born, the subordinates will return and even help the dominant female with the babysitting: she is a close relative and by looking after the young, they are helping to spread some of their genes, too. But the Cambridge team reported that in the cases when a subordinate female does become pregnant, she, too, resorts to infanticide – killing the pups of subordinate sisters and of matriarchs – to boost the chances that her own litter will have enough food to thrive and that even more of her genes pass to the next generation.

Despite the females being closely related, and thus sharing genes, meerkat society appears to be riven by internal conflict, with close parallels to those of social insects such as bees or ants, where infanticide – in the form of egg- and larva-eating – and tactical power struggles are also common, even though colonies and hives are populated by closely-related individuals.

"The meerkat findings show a remarkable similarity to recent work we have done in *Dolichovespula sylvestris* wasps in Britain," said Prof Francis Ratnieks of the University of Sheffield, where he studied the wasps with Dr Tom Wenseleers and colleagues.

The nests consist of colonies of 50-100 wasps with several females that lay eggs, one being the queen and a few workers. The females kill each other's eggs and lay their own eggs in the cells: however, egg-laying workers only kill each other's eggs, while the queen kills eggs laid by the workers. "What we have in both meerkats and the wasps is competition among breeding females for rearing resources manifested in the killing of eggs or infanticide," said Prof Ratnieks.

This is one way, when resources are limited (as they always are), that genes increase the chance that they will be passed on. Selfish genes also explain why co-breeding sister acorn woodpeckers, which lay in the same nest, throw each other's eggs out to increase their contribution to the communal brood. And they reveal why female worker ants prefer to raise young queens, rather than males, to skew the sex ratio of some insect societies.

This genetic gender battle has had a bizarre outcome in the case of the "little fire ant", *Wasmannia auropunctata*. As with other ants, queens combine genes from male sperm with their own, to produce female worker ants, which are sterile. However, when it comes to the next generation of queens, this species has evolved a remarkable trick – to maximise the transmission of their own genes, queens actually clone themselves, rather than incorporating DNA from the male's sperm.

A genetic analysis by Dr Denis Fournier of the Free University of Brussels in Belgium showed that the male ants have evolved their own counter-tactic to ensure that their genes still get passed on: they have found a way to eliminate the female genetic contribution to a fertilised egg, thereby producing a male clone, too.

The battles between genes go deeper than between groups, families and individuals. They go on within our bodies too. We inherit two copies of each gene, one from each parent. However, for some genes, we use the copy from only one parent because of a process called imprinting. Prof David Haig of Harvard University argues that imprinting arose because of the battle between the genes of mother and father: both want to pass on their genes to their offspring, but the genes inherited from the mother and the father are in conflict over how much of her resources the mother should devote to the foetus. In essence, maternally-inherited genes have a greater interest in the survival of the mother than those from the father.

The father wants his offspring to grow big. This will provide his offspring – and his genes – with an enhanced chance of survival and use up the mother's resources so they won't be wasted on another man's offspring. Women, on the other hand, want to provide resources for the growing child, but within reason – they need to retain some resources to ensure their own survival and their potential to pass on more of their genes in future children. The result, Prof Haig says, is an arms race, with paternal genes beefing up the offspring and maternal genes counter-attacking to hold growth in check.

Survival instinct: meerkats will stand on endless sentry duty to protect their young, but if food is short the dominant female will evict subordinates and kill their pups

The battles between genes go deeper than between groups, families and individuals

Look closely at the human genetic code and you will find it swarming with selfish genes. The existence of supposed junk DNA that provides no obvious benefit to our bodies, which was once a puzzle, is easily explained with their help. These genetic parasites, "duplicate me" instructions that have been passed down over the generations, are shaping our inheritance.

With meaningless names such as Lines, Sines, Ltr retrotransposons, and DNA transposons, these parasites make up a significant fraction of our genetic code, representing 13, 20, eight and three per cent respectively, according to Dr Tim Hubbard of the Wellcome Trust Sanger Institute, near Cambridge. Some, like Lines, code for protein machinery that inserts new Lines in our genetic recipe. Others, notably those called Alus, take advantage of the protein machinery produced by the Lines to reproduce. According to Dr Hubbard, "Here we have one kind of selfish DNA feeding off another selfish DNA." Indeed, selfish genes may well have been scrambling our DNA since the dawn of life, some four billion years ago.