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Editorial

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The Genetics Society, in its Spring meetings in the UK, has been attempting a difficult task – to choose themes that will bring together geneticists from across the whole spectrum of the field, people who, in many cases, might otherwise not have much contact with each other. The success of genetics as the cornerstone of modern biology has meant that almost all biologists have been taking a genetic approach to their questions, and, paradoxically, this success has led to genetics itself being fragmented. The hope of the Society's Spring conferences has been that, through the choice of the right unifying theme, some of this fragmentation can be diminished. In this regard, the 29–31 March 2001 meeting on 'Sex', in Warwick, England, was one of the most successful. The meeting, organised by Linda Partridge and Nick Barton, brought together a broad range of speakers, ranging from those studying the mechanisms of recombination, sex and mate recognition in single celled organisms, to those concerned with the implication of genetic progress for the direction of human sexuality.

The success of the meeting prompted the decision to produce this special edition of *Heredity*, giving a series of original reviews which would bring together, and expand in greater depth, some of the most interesting aspects. The result is this issue of the journal, which includes a series of nine contributions from the meeting's speakers, all of which, I am sure, will be of great interest to the readership.

Notwithstanding the near ubiquity of sex in multicellular organisms, we were reminded that recombination, which is the main mechanism through which the effect of sex in generating linkage equilibrium in populations is brought about, itself requires a complex suite of enzyme activities, whose evolution preceded that of multicellularity. Tom Cavalier-Smith considers here the origin of the recombinational apparatus, and suggests that recombination initially arose to facilitate accurate DNA replication itself. Cavalier-Smith points out that true sex, involving nuclear fusion and meiosis, only exists in eukaryotes, and is thus a comparatively recent development. Single-celled eukaryotes, however, differ greatly in their sexual activities from the multicellular organisms with which we are often more familiar. In the ascomycete and basidomycete fungi, sexual dimorphism is rarely found, but, rather, self-fertilisation is prevented by populations containing multiple mating types, controlled by self-incompatibility genes that seem to show a high degree of evolutionary conservation. These genes, and their effects, are reviewed by Lorna Casselton in her contribution.

Other pieces emphasise the importance of sex in the evolutionary biology of multicellular organisms. Tommaso Pizzari and his colleagues present the results of their recent research on sperm competition in the domestic fowl. The results show that sperm competition can be a powerful mechanism for the relative mating fertilisation success of males. Indeed, cryptic female choice of sperm after insemination favours socially dominant males as much as the more obvious female choice prior to insemination. One question raised by the large, and genetically determined, differences in sperm success is why the strong directional selection that this implies does not exhaust the additive genetic variance in the trait. Andrew Clark reports results from *Drosophila* that seem to supply part of the answer. His review shows that relative success of male genotypes in sperm competition is not transitive- if male A's sperm do well in competition against male B's, and B's do well against C's, C might yet out-compete A. Such interactions can lead to interesting evolutionary dynamics, and protected polymorphism, as Clark shows with an unexpected illustration.

The causes of the relative success of ejaculates in *Drosophila melanogaster* are beginning to be well understood, and the ground-breaking research of Mariana Wolfner's group on the diversity, and the effects on the female, of seminal proteins transferred on mating is also reviewed here. EST screens are allowing the identification of the majority of these proteins, and, for some, such as ovulin, which stimulates ovulation in the female, the function is understood. Remarkably, a surprising fraction of these proteins are showing signs that they are changing rapidly through positive Darwinian selection.

Drosophila males and females are equally abundant, which is a consequence of their chromosomal mechanism for sex determination. But with other sex determination mechanisms, other sex ratios are possible. Stuart West, Sarah Reece and Ben Sheldon consider sex ratio determination. Fisher showed that the optimal sex ratio (provided offspring of the two sexes are equally costly to produce) is a half. By producing individuals of the rarer sex, an individual can maximise the number of its F_2 descendants. However, this argument assumes random mating, and if there is sib mating, the expectation is that the sex ratio should be skewed towards females, to a predictable degree. West and his co-authors show that the predictions of sex ratio theory hold remarkably well in a variety of insects and parasites. However, what is more complicated is whether these results also will hold true in organisms with chromosomal sex determination. Jack Werren, Melanie Hatcher and Charles Godfray consider sex chromosomes themselves, and what has led to their evolution. They show that there will often be situations in which the optimal sex ratio for a parent and that for an offspring may differ systematically, and thus the likely sex ratio that will emerge will depend upon whether this is controlled by zygotically-expressed genes, or by maternally-expressed genes. Their results point to the creation of a 'feedback loop', leading to the evolution of a dominant zygotic sex-determining locus. Deborah Charlesworth considers specific cases of the evolution of sex chromosomes, in the broader context of the lability of sexual systems seen in the flowering plants. She suggests

mechanisms that lead to the suppression of recombination in sex determining regions, and the genetic degeneration of the Y chromosome that can result. Spencer Barrett looks at another important consequence of the common sexual system of hermaphroditism in flowering plants. His results point to interference and sexual conflicts between the male and female functions of hermaphrodite flowers.

Taken as a whole, it is striking how many interesting and as yet unsolved questions the study of sexual mechanisms continues to create. It is also clear that the answers to many of these questions will come from a synthesis of experimental and theoretical approaches, ranging from the molecular to the organismal.

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