SCIENCE

Inter-sex 'arms race' leads to new species formation

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In the genes: "We are trying to look at the actual genetic differences that lead to reproductive isolation," says Zeeshan Ali (second from right)

The intensity of the race in fruitflies was tuned by forming separate groups with different ratio of males to females

Since the 1990s, there have been theories of evolution that suggested that antagonism between the sexes can drive the formation of new species. Now, a group from IISER, Mohali has demonstrated this through an experiment involving fruit flies (Drosophila melanogaster). In a paper published in Scientific Reports, they describe their experiment observing the evolution of fruit flies over nearly a hundred generations (spanning about four years).

"There has been only one previous study that provides partial evidence for speciation through arms race. [That study] found differences in females' reluctance to mate — pre-mating isolation. Ours is the first to clearly demonstrate bias in mating preference — [both] pre-mating isolation and bias in sperm preference and post-mating isolation," says Prof. N.G. Prasad of IISER

demonstrate bias in mating preference — [both] pre-mating isolation and bias in sperm preference and post-mating isolation," says Prof. N.G. Prasad of IISER Mohali, whose team came up with the results.

Typically, the sex that invests less in reproduction (usually males) will compete with others of their group for access to the sex that invests more. This induces the male, as the case usually is, to evolve special features, which may be behavioural, chemical or physical, to ensure mating with more females. However, these features may not always suit the females and sometimes could even harm them.

For example, seed beetles evolve a spiny penis, which can "traumatise" the female beetle. In its turn, the female beetle develops thicker skin. Such development of complementary characteristics is called "co-evolution," which is an arms race between the sexes. In the fruitfly, the arms race takes the form of a chemical warfare. The male fruitfly transfers to the female a cocktail of harmful proteins along with sperm while mating. The females adapt to this through behavioural and chemical evolution.

Tuning the race

The team created two main groups of fruit flies: one with an excess of males (M-regime, which had three males for every female) and the another with an excess of females (F-regime, which had three females for every male). Both groups were subdivided into three similar populations that were maintained in separate enclosures and not allowed to interbreed. In the three M regime subgroups, since more males had to compete to mate with fewer females, there was fiercer competition and evolution of males, which in turn set off females' co-evolution. In the F-regime subgroups, since there were more females than males, there was no need for the males to evolve special characteristics, and the arms race was less pronounced. After 100 generations, the M and F regimes evolved into groups that had distinct characteristics.

More interestingly, if the theory of speciation through arms race is correct, and if enhanced arms race should lead to speciation, the following should be observed. The three separate M-regime sub groups (which had enhanced arms race and were not allowed to interbreed) should become reproductively isolated from each other (that is, evolve into different species) while no such differentiation should be seen between the three F-regime groups (which had low arms race and were not allowed to interbreed).

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When this prediction was put to test by allowing all the groups of flies to mate freely, it was found that M-regime males and females preferred to mate with individuals from their own subgroup rather than with mates from a different one. This was not the case with members in the F-regime.

Post-mating scenario

What is remarkable is that such a preference, or bias, was carried over even after mating, that is, in choosing between sperms from different males. The female fruitfly is promiscuous and carries more than one male's sperm in her sperm storage organ. There the sperms compete for fertilising the egg.

The team found that the males in M-regime lose out in this race if the female they mate with is from a different population (subgroup). So the chances of an offspring emerging after mating males from one of the M-regime subgroups with a female from a different subgroup are low. This was not true of males from the F-regime subgroups, where the arms race was less pronounced.

The group plans to take their research further. "We are trying to study the mechanistic basis of the reproductive isolation and also other characteristics, such as pheromones, that might have evolved. We are trying to look at the actual genetic differences that lead to reproductive isolation in these populations," says Zeeshan Ali, lead author of the paper.