**Sex and the elimination of copying errors**

Experimenting with computerised genetic algorithms might be a very poor substitute for some hard-nosed research but sometimes such experimentation can point the way to future research or, as is the case with this paper, confirm the conclusions of previous research.

The algorithm written for this brief paper is very simple and routine. It consists of 20 organisms each composed of 100 genes. Gene number one is deemed to have perfect fitness if it has the value 1, gene two has perfect fitness if it has the value 2, etc. Once every generation each gene has a one in a thousand chance of being mutated and if selected will have its value increased by 10. Also once every generation two higher-fitness organisms will be selected for crossover and reproduction (two offspring per pairing) and two lower-fitness organisms will be eliminated (thereby keeping the population at 20). And finally, once every generation two organisms will be chosen at random for a fight to the death and the competitor with the higher fitness will make an extra copy of itself and the loser will be eliminated. The measure of fitness for each gene will be the arithmetical difference between the perfect score (i.e. 1 for gene one, 2 for gene two, etc.) and the actual value of the gene. This means that lower fitness equates with a higher arithmetical difference and a difference of zero equates with perfect fitness.

Some of the elements of the algorithm can be excluded or included in different combinations. The sexual selection element includes the selection of two higher-fit organisms and the deletion of two lower-fit organisms but crossover is treated as a separate element.

The algorithm is run for 2000 generations and the average fitness of all members of the entire population is calculated every 100 generations.

What can be gleaned from the various outputs of the algorithm? If we regard the mutations as a proxy for copying errors then four of the above runs of the algorithm can eliminate the errors and two can’t. It is immediately clear that the presence of the sexual selection element is a pre-requisite for the elimination of copying errors: natural selection, on its own (**B**) leads to a never-ending accumulation of copying errors even when it is combined with crossover (**F**). Is the elimination of copying errors the real reason for the existence of sexual selection? If it is, then some kind of sexual selection must exist in the world of single-celled organisms. The University of East Anglia point to the evidence for the purpose of sexual selection amongst multi-cellular creatures and The University of Exeter point to the evidence for a form of sexual selection amongst single-celled organisms. (References below).

A comparison of the different levels of fitness between Columns **B** and **F** demonstrate that there may be some survival advantage for crossover, without sexual selection, when it is combined with natural selection, but there is certainly not enough advantage to fight off mutational meltdown. What then is the use of crossover? Horizontal transfer of elements of genomes between different organisms has been around from day one and therefore we might conclude that it is an absolutely fundamental key to understanding evolution. Radomir Crkvenjakov places horizontal transfer, especially between different species, at the heart of his explanation of the sometimes rapid appearance of new species. His monograph not only supports his ideas on the evolution of complexity but also interweaves his theory into an incredibly comprehensive and compact summary of all the major areas of Evolutionary Theory. I’m sure he would send you a copy if you contact him via ResearchGate.

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Sexual Selection Protects Against Extinction. **University of East Anglia**.

Sexual Selection in Bacteria**. University of Exeter**.