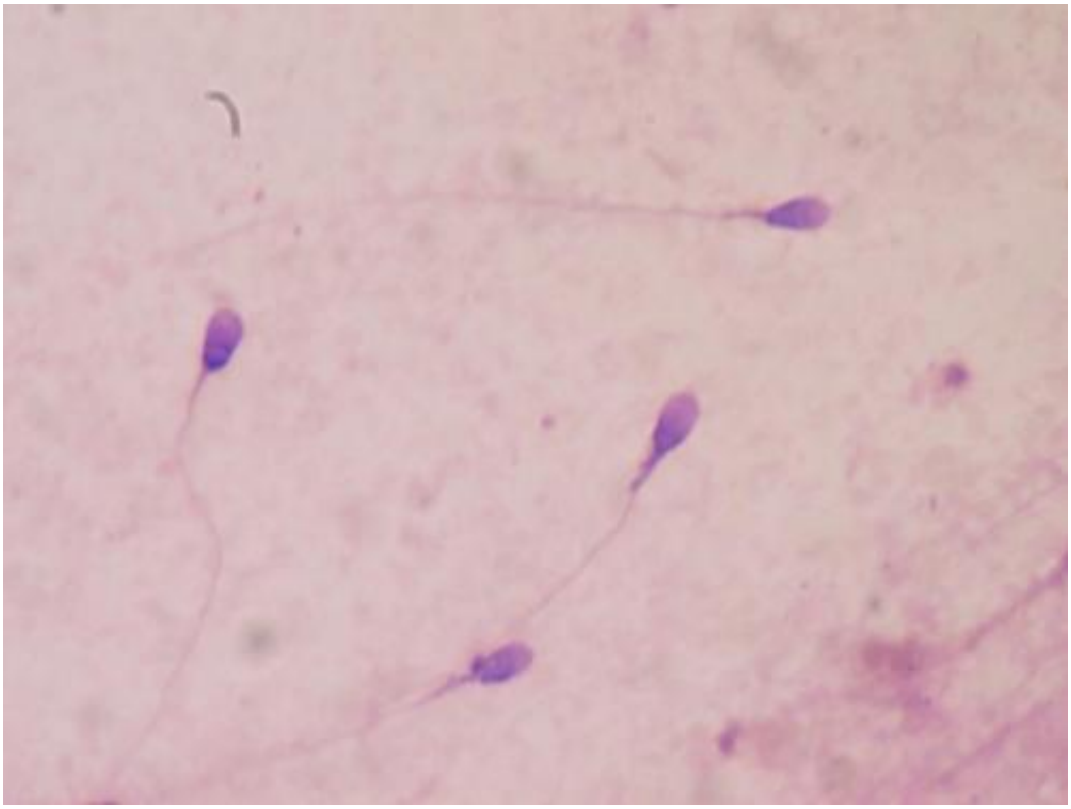
Not every sperm is sacred: Longer-lived sperm produce healthier offspring

July 10 2017



Human sperm stained for semen quality testing in the clinical laboratory. Credit: Bobjgalindo/Wikipedia

Males produce hundreds of thousands to hundreds of millions of sperm within a single ejaculate depending on the species. Does it matter then which sperm is actually fertilising the egg?

Research published today shows that selecting for longer-lived sperm within the ejaculate of a male results in offspring with better survival prospects early in life and higher quality as adults.

The study by the University of East Anglia, UK and Uppsala University, Sweden, could have major implications for adaptive evolution and research into assisted fertilisation technologies, such as IVF.

Until now it has been assumed that in animals, fertile sperm within a single ejaculate are all equally capable of producing viable offspring. Little has been done to investigate the importance of selection - where environmental influences determine, which types of organism thrive better than others - on sperm and the offspring it produces.

Published in the journal *PNAS*, the study used externally fertilising zebrafish Danio rerio to show that selection on intact fertile sperm within a single ejaculate affects the fitness of offspring, and also carries these differences on to the next generation.

Dr Simone Immler, a European Research Council Fellow in UEA's School of Biological Sciences, said: "We found that selection for longer-lived sperm produced offspring which had increased chance of survival and performed better as adults than their siblings sired by non-selected control sperm. Thus, it is possible to get rid of the lower quality sperm within an ejaculate through selection on sperm performance.

"Male offspring sired by longer lived sperm in particular exhibited higher fitness. The effect also carried over to the next generation in both sexes."

The study demonstrated that sperm with different characteristics existing within an ejaculate of a single male zebrafish also differed in their genetic composition. In other words, it showed that the genes residing

within each sperm could affect its performance - an idea that to date has been rejected.

Scientists selected sperm based on longevity and using in vitro fertilisation (IVF) to allow them to control the timing between sperm activation - which occurs on contact with water - and fertilisation.

Sperm were either activated immediately and added to eggs in a so-called 'short activation time' (SAT) treatment, or held until 50 per cent of the sperm were no longer mobile and then added to eggs in a 'long activation time' (LAT) treatment.

Offspring sired by the LAT sperm showed a 7 per cent increase in survival over offspring from the SAT sperm. Furthermore, sons from LAT sperm produced significantly faster swimming sperm.

Next, the reproductive success of the adult male and female offspring produced by the first experiment were assessed. While there was no difference between LAT and SAT females for fertilisation success, it was higher in LAT males by 4 per cent. Also, females mated to LAT males produced 20 per cent more eggs than those mated to SAT males.

Dr Immler said: "This clearly demonstrates how selection on one trait of sperm within a single ejaculate - in this case its longevity - can have a significant effect on the offspring produced. Fitness traits were strongly affected by sperm selection not only in the immediate offspring but also persisted in the next generation.

"Variation in sperm produced by the same male in a single ejaculate has pronounced effects on various fitness-related traits throughout life and this variation has a genetic basis. These findings are intriguing and could explain why such variation in performance among sperm exists.

"Our findings are likely to have major implications for key evolutionary processes, as well as providing insights that are crucial for clinical and agricultural assisted fertilisation techniques such as IVF. These techniques currently omit many if not all naturally-occurring steps of within-ejaculate sperm selection, the consequences of which need to be understood."

'Haploid selection within a single ejaculate increases offspring fitness' is published in the journal *Proceedings of the National Academy of Sciences* (*PNAS*).

More information: Ghazal Alavioon el al., "Haploid selection within a single ejaculate increases offspring fitness," *PNAS* (2017). www.pnas.org/cgi/doi/10.1073/pnas.1705601114

Provided by University of East Anglia