Sperm proteome gives 'tantalising glimpse' towards the origin of sex

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The first ever catalogue of the different types of proteins found in sperm could help reveal the origins of sex and explain some of the mysteries of infertility, say scientists.

Research published in *Nature Genetics* today describes 381 proteins present in sperm of the fruit fly, Drosophila melanogaster. Whilst more proteins may be identified as research progresses, this study marks the first substantial 'whole-cell' characterisation of the protein components of a higher eukaryotic cell (a cell in which all the genetic components are contained within a nucleus).

This so-called 'proteome' contains everything the sperm needs to survive and function correctly, and scientists can use it to investigate the factors that make some sperm more successful than others.

Around half of the genes of the fruit fly sperm proteome have comparable versions in humans and mice, making it a useful model for studying male infertility in mammals.

By comparing the sperm proteome of the fruit fly with other species, scientists will also be able to rewind evolution and work out the core sperm proteome – the most basic constituents a sperm needs for sexual reproduction. This will shed light on how sex itself evolved.

"This is the first catalogue of sperm proteins for any organism, and it offers a tantalising glimpse into how we might begin to answer some of

biology's most fundamental questions," said Dr Tim Karr from the University of Bath who led the study.

"Amazingly we know very little about what is in a sperm, which probably explains why we don't really understand sex, let alone how it evolved.

"Before we catalogued the sperm proteome, we only knew a few specific proteins in the Drosophila sperm.

"Being able to compare the structure and content of the proteomes of sperm from different species should help us understand the evolution and origin of sperm.

"We now know of at least 381, which is a greater than 50-fold increase in our knowledge base. Now that we have identified them, we should be able to study the function of all of these."

Proteins carry out an immense range of functions, from forming structural materials to catalysing chemical reactions, so knowing exactly what proteins are in sperm is a great step forward in understanding.

The research involved purifying fruit fly sperm and developing methods to study their protein content. Previous estimates for the protein content of sperm were based on counts of proteins separated into 'spots' on a special gel matrix. However, these only identify the total number of proteins in sperm – rather than identifying the specific identity of each protein constituent

"The sperm proteome provides a basis for studying the critical functional components of sperm required for motility, fertilisation and possibly early embryo development," said Dr Steve Dorus, also from the University of Bath, who collaborated with Dr Karr on the project.

“It should be a valuable tool in the study of infertility as more targeted studies can now be established in model organisms.

“Furthermore, having a comprehensive catalogue of proteins to compare between different species will reveal how natural selection has impacted sperm evolution.

“We can start to look for the ‘core’ sperm proteome - that is, the most basic required constituents of sperm. This will not only shed light on the evolutionary origins of sperm, but may advance our understanding of the evolution of sex itself.”

The research will also help further our understanding of sperm competition – the attributes within a sperm that make one sperm more successful at reaching and fertilising the egg than its peers.

“This question of sperm competition has baffled scientists for years,” said Dr Karr.

“If we can work out what makes one sperm more successful than another, we might be able to apply this knowledge to clinical therapies for the treatment of sperm that are not functioning properly.”

The findings are particularly timely as a variety of research is beginning to highlight the increasingly important role of sperm.

Scientists are discovering that as well as carrying the DNA that spells out the male’s contribution to a new life, sperm carries RNA and proteins which have a direct influence on fertilisation and embryo development.

Professor Geoff Parker, Derby Professor of Zoology at the University of Liverpool, said: "This paper provides a remarkable, pioneering analysis of the molecular basis of sperm form and function by identifying 381

proteins of the Drosophila melanogaster sperm proteome, including mitochondrial, metabolic and cytoskeletal proteins.

“Their work has great relevance to current debate on the evolutionary underpinnings of sperm characteristics, and may have application to mammalian sperm function. The Drosophila sperm proteins show substantial homology with the axoneme accessory structure of mouse sperm.”

Professor Manyuan Long, Professor of Genetics & Evolution at the University of Chicago, said: “This is a milestone in the understanding of genomic distribution of male specific proteins. I marvel at their tremendous efforts and great successes.”

Source: University of Bath