In search of lost genes

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The fruit fly Drosophila was the genetic model that the researchers used for their studies. Credit: Markus Riedl/Vetmeduni Vienna

It is well known that genes are passed from one generation to the next. In addition, new genes arise regularly, although the number of genes in a particular organism does not seem to increase. The paradox has been solved by recent research at the University of Veterinary Medicine, Vienna, which shows that newly created genes are frequently lost. The spontaneous appearance and disappearance of genes enables organisms to adapt rapidly to their environment and helps drive evolution. The work is published today in the journal eLife.

How do new genes arise? Current research shows that so-called "orphan genes" may appear as if by magic as a result of mutations in segments of DNA that previously had no function. Orphan genes were first discovered in the fruit fly but are found in all organisms, including man. Strikingly, up to 30 per cent of the total number of genes in an organism may be orphans and these genes may rapidly acquire functions. Scientists from the Institute of Population Genetics of the University of Veterinary Medicine, Vienna (Vetmeduni) have now investigated the fate of orphan genes. They show for the first time that orphan genes are frequently lost and consider the factors the influence the "survival" of the young genes.

Young orphans are at greatest risk

Together with Christian Schlötterer, the Head of the Institute, and other colleagues, Nicola Palmieri investigated the genes in a European species of fruit fly (*Drosophila pseudoobscura*). The scientists compared the genetic sequence of five related strains of the species, looking for orphan genes and examining the life cycles of the various genes in the fly genome. They discovered that most orphan genes persist for relatively few generations. As Schlötterer explains, "Some genes last for a long time through the evolution of species: these are known as conserved genes. Orphan genes represent the exact opposite: they come and go. Interestingly the youngest orphan genes seem to disappear the fastest. Orphan genes that are 'older' are more likely to remain in the genome."

The researchers identified a number of factors that determine the length of time a young gene remains in a population. Active genes, i.e. those that produce a large amount of RNA, seem more likely to be retained than less active genes; and genes that are more active in males than in females also persist for longer.

Life on the X chromosome: short and sweet

Another important factor is the precise position where an orphan gene is located. When a new gene arises on the X chromosome (males have one X chromosome and females two) it is likely to cease functioning much faster than genes that arise on other chromosomes. Surprisingly, though, there are more orphans on the X chromosome than at other sites in the genome. It is currently unclear why this is so, despite the apparent existence of a mechanism that makes it hard for orphan genes to "survive" on the X chromosome. Life on the X chromosome may be short but it is clearly attractive.

Important tools for evolution

Schlötterer is keen to emphasize the importance of orphan genes for evolution. "Orphan genes are probably extremely important for rapid, short-term adaptations, when a species needs something new and innovative. When they are no longer needed they can be quickly removed from the genome." Recent work in another group has shown how orphan genes can arise: Palmieri and Schlötterer's work now completes the picture by showing how and when they disappear.

The article "The life cycle of Drosophila orphan genes," by Nicola Palmieri, Carolin Kosiol and Christian Schlötterer was published in the journal *eLife*.

More information: Read the complete paper here: arxiv.org/ftp/arxiv/papers/1401/1401.4956.pdf

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