Nature Reviews Genetics | AOP, published online 24 April 2014; doi:10.1038/nrg3737


Getty

DEVELOPMENT

Germ plasm 'fuels' vertebrate evolution

In vertebrates, primordial germ cells — the ancestors of germ cells — can arise from one of two species-specific processes: epigenesis (that is, from pluripotent cells through induction by somatic signals) or preformation, which is a cell-autonomous process determined by the inheritance of the maternal germ plasm. A paper published in *Science* now shows that the evolution of germ plasm accelerates the rate of evolution within individual animal lineages and thus represents a major contributor to species diversity.

As germ plasm evolved independently in many animal lineages — which suggests convergent evolution — it was thought to confer a selective advantage. One of the corresponding authors, Andrew D. Johnson (University of Nottingham), previously proposed that the selective advantage that drives the emergence of germ plasm in vertebrates is the disengagement of germline specification from somatic influences, which would free the evolution of gene regulatory networks that govern somatic development and thereby enhance species evolvability.

In this study, the researchers combined various bioinformatic techniques into a comprehensive pipeline to analyse sequence change across almost all known protein-coding sequences in vertebrates. Simple four-taxon trees were constructed on the basis of high-quality sequence alignments to investigate the relationships between species using epigenesis and those using preformation. Moreover, the relative-rate test was used to determine whether sequences in species that use preformation were changing at different rates. These results showed that species using preformation have a faster rate of sequence evolution than those using epigenesis. In other words, genes evolve more rapidly in species with germ plasm. "The sequences that are evolving at different rates have a tendency to be expressed during early development," says Johnson. "We have previously shown dramatic differences between axolotls and *Xenopus* with sequences expressed during early development, but we were not prepared for the scale of the differences we observed here."

The study supports the hypotheses that germ plasm liberates constraints on somatic development and that enhanced evolvability drives the evolution of germ plasm. "Our study reinforces the concept that mammals evolved from basal vertebrates, represented by the axolotl as a model," adds Johnson. "We will continue to use the axolotl model to identify the core gene regulatory networks for early development that were adapted as mammals evolved, to provide unique insights into how vertebrates evolved and how the early development of human embryos is controlled."

Linda Koch

ORIGINAL RESEARCH PAPER Evans, T. *et al.* Acquisition of germ plasm accelerates vertebrate evolution. *Science* **344**, 200–203 (2014)