

## PRESS RELEASE

To the professionals of press and media  
Geneva, March 1<sup>st</sup> 2010



UNIVERSITÉ  
DE GENÈVE

**ATTENTION: INFORMATION EMBARGOED UNTIL MARCH 3<sup>RD</sup>, 6 P. M., LONDON TIME**

# An invasion of jumping genes may have sparked off reptile diversity

Professor Denis Duboule's team in Switzerland reveals how architect genes have evolved and led to the formation of snakes and lizards, while abiding by the rules of the body plan

**Among all reptiles, squamates are the ones that deserve the gold medal of diversity. This group, which comprises lizards and snakes, displays indeed an amazing realm of morphologies. Understanding how the body plan of these animals has evolved and led to the formation of such drastically different organisms is a challenge that was taken up by the team of Denis Duboule, director of the National Centre of Competence in Research Frontiers in Genetics. The researchers reveal in the 4th March 2010 edition of Nature magazine various subterfuges employed during the evolution of architect genes. The latter, named Hox genes, are essential for coordinating body patterning during embryonic development. Rearrangements and mutations discovered within these genes enable to visualise the transition between lizards and snakes. The geneticists also show that an invasion of transposons, genes capable of moving within the genome, may be at the root of the flexibility observed in the squamates' body plan.**

The squamates, which encompass 7'000 odd species, constitute a group of tremendous diversity. It includes both the dwarf gecko, a mere sixteen millimetre long lizard, and the green anaconda, the famous nine meter long snake. The species also display a highly variable number of vertebrae, up to 400 in the case of the latter. How could such audacious and versatile morphological lines have been drawn from a common initial blueprint, during evolution?

### THE «TIME-SPACE» CONSTRAINT

Key elements to address this question are unveiled in the study of a team led by Denis Duboule, geneticist at the University of Geneva (UNIGE) and the School of Life Sciences, Federal Institute of Technology (EPFL), in Switzerland. In particular, the scientists have shown how modifications in the structure and function of "architect genes", the Hox genes, have led to a complete reorganization of the snakes' skeleton.

Hox genes coordinate the formation of structures during embryonic life, such as vertebrae in the spine, assigning to each of them a precise form and location. The synchronisation of construction operations is, however, subject to a time and space constraint: the architect genes are indeed aligned on the chromosomes in the order in which they are expressed. The first ones will thus be active more precociously during embryonic development and will be expressed in the most anterior structures of the organism.

## WHEN ARCHITECT GENES BECOME LAX

“Given their complex and essential functions, Hox genes are submitted to very strict rules. Normally, this leaves little margin for the introduction of drastic modifications”, points out Nicolas Di-Poi, from the National Centre of Competence in Research Frontiers in Genetics. The biologists have nevertheless discovered with surprise that the regions of the genome containing Hox genes were much larger in squamates than in the other reptiles. This results from a massive and unexpected invasion of these regions by mobile DNA elements named transposons. Composed of DNA sequences capable of moving within the genome in an autonomous way, present in all living beings, these “jumping genes” are considered as real motors of evolution, their mobility being a source of mutations.

“This accumulation of transposons has probably facilitated the adaptations that have accompanied the morphological transition from short lizard-like to elongated snake-like body forms”, explains Denis Duboule. A window of opportunity has occurred during evolution of the squamate body plan. The outcome was a loosening in the function and the regulation of architect genes and a complete reorganisation of snakes’ structure.

## HOW SNAKES HAVE LOST THEIR PELVIS

These changes have led to a substantial increase in the number of vertebrae in snakes and the disappearance of the lumbar region. All of their vertebrae indeed bear ribs, except for those of the neck and the tail. “The architect genes intervening to block rib formation have mutated in these reptiles. Their loss of activity has led to an unprecedented expansion of the thoracic region, due to the lack of a stop signal”, adds Denis Duboule. The elongation of the caudal region is probably also the consequence of an alteration in Hox genes responsible for halting the tail’s growth.



Corn snake (*pantherophis guttatus*) © Labo LANE (UNIGE)

The amazing morphological diversity of reptiles is reflected in the audacious way these genes have reorganised, while respecting the time and space constraint. It would be interesting to know whether natural selection has exploited a similar flexibility in developmental mechanisms of other groups of vertebrates. ■

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